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Model Aircraft L-Band Beacon Antenna Pattern Gain Maps

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24 April 1975

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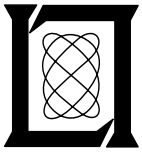

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16. Abstract

This document presents L-band antenna patterns for a variety of general aviation and air carrier aircraft; these patterns were based on scale-model measurements. The antenna patterns are described by aircraft-coordinate-referenced elevation vs azimuth gain-contour maps. This method of presentation conveniently displays the effects of aircraft configuration on antenna patterns and allows one to observe the changes in a pattern that result from a change in wheel, flap, or antenna location.

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TABLES

Model Aircraft L-Band Beacon Antenna Pattern Gain Maps

I. Introduction

As part of the DABS program, Lincoln Laboratory has formulated and carried out a program that measures aircraft L-band beacon antenna patterns on a variety of scale-model aircraft. These aircraft included single- and twin-engine general aviation types, small business jets and several medium to large air carrier jets. The purpose of this report is to present the gain patterns in a form that is convenient to the reader.

Each of the aircraft models was constructed to allow at least two antenna locations and positions of the landing gear and flaps. Thus, several patterns were obtained for each of the models. As a large data base accumulated the alternates for graphically presenting the L-band beacon antenna, gain data were compared with more than casual interest. The "developed cylinder" plots (gain contours related to airframe referenced elevation vs azimuth coordinates), as used in this report, were selected as a visual, quickly accessed and understood type of gain plot.

II. Measurement Procedure

Eleven model aircraft were measured. Keeping and Sureau [Ref. 1] have documented the results for seven aircraft measured at Lincoln Laboratory. The remaining four aircraft were measured at the Boeing Commercial Airplane Company and documented in Ref. 2. A detailed analysis of some of the gain data has been accomplished by Schlieckert [Ref. 3].

The models constructed were scaled 1/20 to 1/40 the size of the actual aircraft, requiring that the test frequencies be 20x to 40x that of the L-band frequencies employed by the beacon antenna whose patterns were sought, i.e., to 20 to 40 GHz. The higher frequencies were used on only the air carrier models. Vertical polarization was used in most cases (only a few of the air carrier models were measured using horizontal polarization). Measurements of the gain pattern were collected over the entire sphere (4π steradians). Figure 1-1 details the aircraft-oriented coordinate system with the φ azimuthal plane angle measured counterclockwise from the +X direction (right wing); the elevation plane angle θ measured from the +Z axis (vector normal to wings) in a clockwise direction; and the pitch axis, +Y, aligned with the nose of the model.

To obtain gain values over the 4π steradians, the measurement procedure was to begin at $\theta = 1^{\circ}$, $\varphi = 0^{\circ}$ for the general aviation models, and $\theta = 0^{\circ}$ for the air carrier models; then incrementing φ in 2° increments for a total of 180 points for that particular θ value. By repeating this

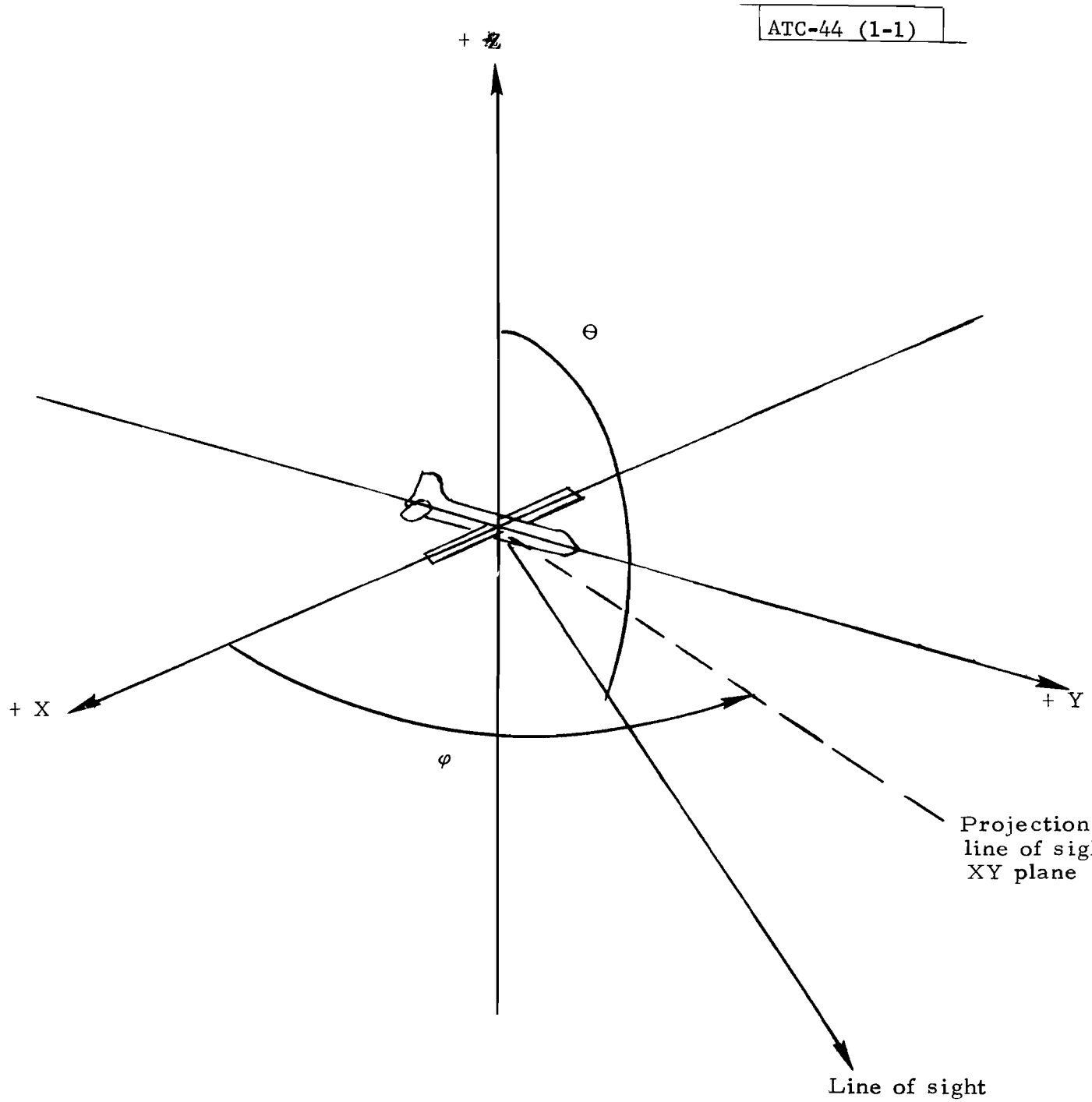

Fig. 1-1. Aircraft coordinate system.

procedure after each 2^{o} increment in θ, a total of 16,200 or 16,380 gain values were generated for each general aviation or air carrier model gain map, respectively. Then the values were normalized to an isotropic antenna (dbi) by integrating over all the values generated [Ref. 1].

III. Map Generation and Usage

Previously, aircraft gain patterns were usually represented by polar plots, with one of the aspect angles held constant as the other was varied. The illustrations provided in this report take that idea a step further by including the 90 or 91 θ planes in one diagram. By assigning a character to a 10-db band and printing out the character at each data point, an L-Band gain "map" was generated. See Figs. 2-1 to 12-6; these maps provide useful information regarding the effects of changes in antenna position for a particular airframe. Another use of the gain maps is to characterize the effects of signal blockage by various parts of the aircraft structure and to indicate pictorially how these effects change if flaps and/or wheel positions are changed. This type of study has been accomplished by Schlieckert [Ref. 3] for typical aircraft. A further use of the L-Band data is the study of improvements resulting from ground and/or air diversity.

Tables 1 through 4 provide an index to the model aircraft pattern "maps." The table entries note for each aircraft type: the antenna positions, the gear and flap conditions, and the polarization used during the model pattern measurements. Antenna positions are pictured (and identified by antenna position number) in top and bottom views of the model aircraft (Figures 1-2 through 1-26).

Since vertically polarized radiation was used throughout the general aviation model aircraft measurements; Tables 1, 2, and 3 do not tabulate polarization. Both vertically and horizontally polarized radiation were used for the air carrier model measurements, and the polarization is identified in Table 4. Note also that the flap condition was always "up" (flaps seated) during the air carrier measurements. Two-numeral codes used during the model measurements to succintly identify antenna position and gear conditions are explained in Appendix A. (These code numbers appear in the "conditions" block at the top of each map.)

IV. Reading the Maps

To provide a simple example of the way in which the airframe/antenna pattern maps may be used, suppose that it is desired to compare the gain performance of the Cessna 150 top antenna (position 1) with that of the bottom antenna (position 3). Table 1 indicates that Figs. 2-1 and 2-5 should be compared (flaps "up" condition for both cases).

To examine first-order effects, compare the clear areas of each map, i.e., the areas representing gain greater than unity (0 db) for the antenna as

influenced by its surrounding airframe. As might be expected, the top-mounted antenna provides its greatest gain above the aircraft x-y plane (defined by aircraft nose-tail and wingtip-wingtip axes), and the gain of the upper antenna appears to be influenced only slightly by the tail structure (rudder) of the aircraft. It can also be seen that the gain of the top-mounted antenna exceeds 0 dB within and below the x-y plane of the aircraft within only infrequent and narrow azimuthal sectors, primarily on each side of the aircraft tail structure.

Examining Fig. 2-5, it is seen that the gain for the bottom-mounted antenna (position 3) is predominantly below the x-y plane of the aircraft and markedly influenced by the extended nosewheel of the aircraft.

Higher-order effects may then be observed by progressively comparing the areas of the two diagrams denoted by "dots," "slashes," and "percentage" symbols.

TABLE 1

SINGLE ENGINE AIRCRAFT PATTERNS*

AIRCRAFT	ANTENNA FIG. NO.	POSITION ANT. NO.	GEAR CONDITION WHEELS	FLAPS	MAP FIGURE NO.
CESSNA 150	1-2	--			
	1-3	1 (T)†	DOWN	UP	2-1
	1-3	1 (T)	DOWN	DOWN	2-2
	1-4	2 (B)**	DOWN	UP	2-3
	1-4	2 (B)	DOWN	DOWN	2-4
	1-4	3 (B)	DOWN	UP	2-5
	1-4	3 (B)	DOWN	DOWN	2-6
	1-4	4 (B)	DOWN	UP	2-7
	1-4	4 (B)	DOWN	DOWN	2-8
PIPER CHEROKEE	1-5	--			
	1-6	1 (T)	DOWN	UP	3-1
	1-6	1 (T)	DOWN	DOWN	3-2
	1-6	2 (T)	DOWN	UP	3-3
	1-6	2 (T)	DOWN	DOWN	3-4
	1-6	2 (T)	UP	UP	3-5
	1-6	2 (T)	UP	DOWN	3-6
	1-7	3 (B)	DOWN	UP	3-7
	1-7	3 (B)	DOWN	DOWN	3-8
	1-7	3 (B)	UP	UP	3-9
	1-7	3 (B)	UP	DOWN	3-10
	1-7	4 (B)	DOWN	UP	3-11
	1-7	4 (B)	DOWN	DOWN	3-12
	1-7	4 (B)	UP	UP	3-13
	1-7	4 (B)	UP	DOWN	3-14
HELIO U10D	1-8	--			
	1-10	1 (B)	DOWN	UP	4-1
	1-10	1 (B)	DOWN	DOWN	4-2
	1-10	2 (B)	DOWN	UP	4-3
	1-10	2 (B)	DOWN	DOWN	4-4

* Vertical polarization used for all measurements.

† (T) Top mounted.
**(B) Bottom mounted.

TABLE 2

TWIN ENGINE AIRCRAFT PATTERNS*

AIRCRAFT	ANTENNA FIG. NO.	POSITION ANT. NO.	GEAR CONDITION WHEELS	GEAR CONDITION FLAPS	MAP FIG. NO.
BEECH BARON	1-11				
	1-12	1 (T)†	DOWN	UP	5-1
	1-12	1 (T)	DOWN	DOWN	5-2
	1-12	1 (T)	UP	UP	5-3
	1-12	1 (T)	UP	DOWN	5-4
	1-12	2 (T)	DOWN	UP	5-5
	1-12	2 (T)	DOWN	DOWN	5-6
	1-12	2 (T)	UP	UP	5-7
	1-12	2 (T)	UP	DOWN	5-8
	1-13	3 (B)**	DOWN	UP	5-9
	1-13	3 (B)	DOWN	DOWN	5-10
	1-13	3 (B)	UP	UP	5-11
	1-13	3 (B)	UP	DOWN	5-12
	1-13	4 (B)	DOWN	DOWN	5-13
	1-13	4 (B)	UP	UP	5-14
	1-13	4 (B)	UP	DOWN	5-15
BEECH BARON 99	1-14				
	1-15	1 (T)	DOWN	UP	6-1
	1-15	1 (T)	DOWN	DOWN	6-2
	1-15	2 (T)	DOWN	DOWN	6-3
	1-15	2 (T)	UP	UP	6-4
	1-15	2 (T)	UP	DOWN	6-5
	1-16	3 (B)	DOWN	UP	6-6
	1-16	3 (B)	DOWN	DOWN	6-7
	1-16	3 (B)	UP	UP	6-8
	1-16	3 (B)	UP	DOWN	6-9
	1-16	4 (B)	DOWN	UP	6-10
	1-16	4 (B)	DOWN	DOWN	6-11
	1-16	4 (B)	UP	UP	6-12
	1-16	4 (B)	UP	DOWN	6-13
	1-16	5 (B)	DOWN	DOWN	6-14
	1-16	5 (B)	UP	UP	6-15
	1-16	5 (B)	UP	DOWN	6-16

* Vertical polarization used for all measurements.

† Top mounted (T).

** Bottom mounted (B).

TABLE 3

SMALL JET AIRCRAFT PATTERNS*

AIRCRAFT	ANTENNA FIG. NO.	POSITION ANT. NO.	GEAR CONDITION WHEELS	GEAR CONDITION FLAPS	MAP FIG. NO.
GATES LEAR JET	1-17				
	1-18	1 (T)†	DOWN	UP	7-1
	1-18	1 (T)	DOWN	DOWN	7-2
	1-18	1 (T)	UP	UP	7-3
	1-18	1 (T)	UP	DOWN	7-4
	1-18	2 (T)	DOWN	UP	7-5
	1-18	2 (T)	DOWN	DOWN	7-6
	1-18	2 (T)	UP	UP	7-7
	1-18	2 (T)**	UP	DOWN	7-8
	1-19	3 (B)	DOWN	UP	7-9
	1-19	3 (B)	DOWN	DOWN	7-10
	1-19	3 (B)	UP	UP	7-11
	1-19	3 (B)	UP	DOWN	7-12
	1-19	4 (B)	DOWN	UP	7-13
	1-19	4 (B)	DOWN	DOWN	7-14
	1-19	4 (B)	UP	UP	7-15
	1-19	4 (B)	UP	DOWN	7-16
	1-19	5 (B)	DOWN	UP	7-17
	1-19	5 (B)	DOWN	DOWN	7-18
	1-19	5 (B)	UP	UP	7-19
	1-19	5 (B)	UP	DOWN	7-20
GRUMMAN GULFSTREAM	1-20				
	1-21	1 (T)	DOWN	UP	8-1
	1-21	1 (T)	UP	UP	8-2
	1-21	1 (T)	UP	DOWN	8-3
	1-21	2 (T)	DOWN	UP	8-4
	1-21	2 (T)	UP	UP	8-5
	1-22	3 (B)	DOWN	UP	8-6
	1-22	3 (B)	DOWN	DOWN	8-7
	1-22	3 (B)	UP	UP	8-8
	1-22	3 (B)	UP	DOWN	8-9
	1-22	4 (B)	DOWN	UP	8-10
	1-22	4 (B)	UP	UP	8-11

* Vertical polarization used for all measurements.

† Top mounted (T).

** Bottom mounted (B).

TABLE 4

AIR CARRIER PATTERNS*

AIRCRAFT	ANTENNA POSITION	WHEEL POSITION	POLARIZATION	MAP FIG. NO.
BOEING 707 (Fig. 1-23)	TOP	UP	VERT	9-1
	TOP	UP	HORIZ	9-2
	BOTTOM	UP	VERT	9-3
	BOTTOM	UP	HORIZ	9-4
	BOTTOM	DOWN	VERT	9-5
	BOTTOM	DOWN	HORIZ	9-6
BOEING 727 (Fig. 1-24)	TOP	UP	VERT	10-1
	TOP	UP	HORIZ	10-2
	BOTTOM	UP	VERT	10-3
	BOTTOM	UP	HORIZ	10-4
	BOTTOM	DOWN	VERT	10-5
	BOTTOM	DOWN	HORIZ	10-6
BOEING 737 (Fig. 1-25)	TOP	UP	VERT	11-1
	TOP	UP	HORIZ	11-2
	BOTTOM	UP	VERT	11-3
	BOTTOM	UP	HORIZ	11-4
	BOTTOM	DOWN	VERT	11-5
	BOTTOM	DOWN	HORIZ	11-6
BOEING 747 (Fig. 1-26)	TOP	UP	VERT	12-1
	TOP	UP	HORIZ	12-2
	BOTTOM	UP	VERT	12-3
	BOTTOM	UP	HORIZ	12-4
	BOTTOM	DOWN	VERT	12-5
	BOTTOM	DOWN	HORIZ	12-6

* Flaps "up" (seated) always.

Fig. 1-2. Cessna 150, three-quarter view.

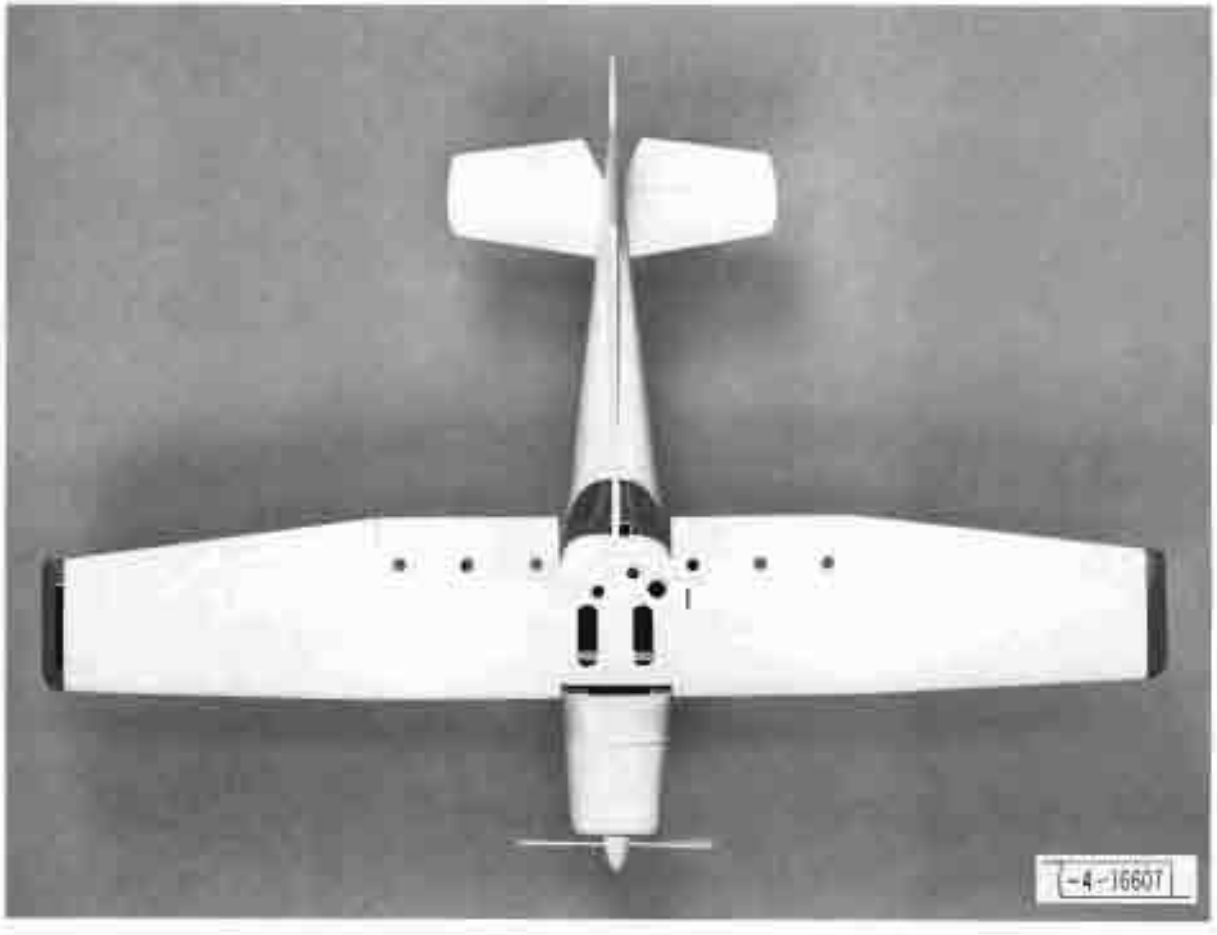

Fig. 1-3. Cessna 150, top view showing antenna position 1.

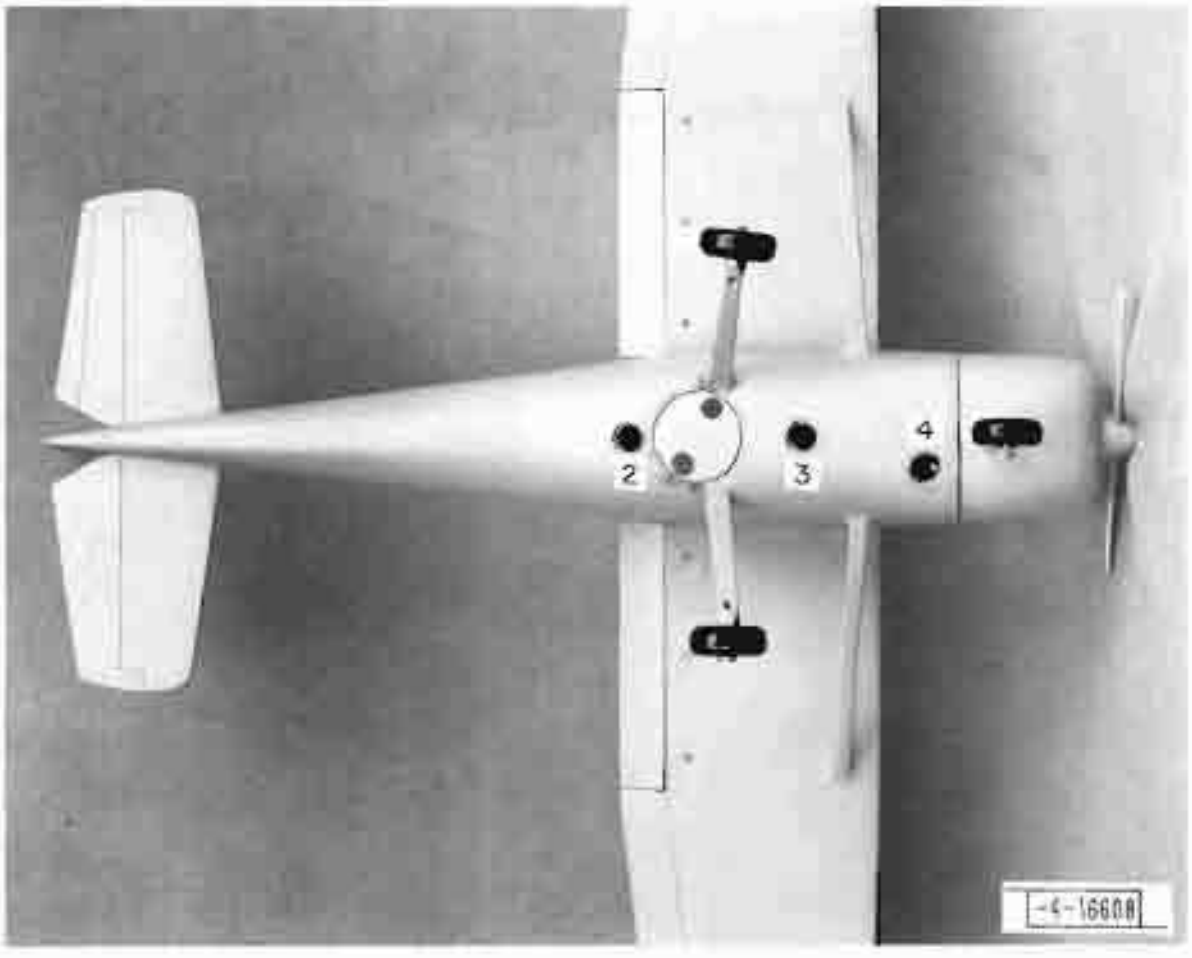

Fig. 1-4. Cessna 150, bottom view showing antenna positions 2, 3 and 4.

Fig. 1-5. Piper Cherokee Arrow, three-quarter view.

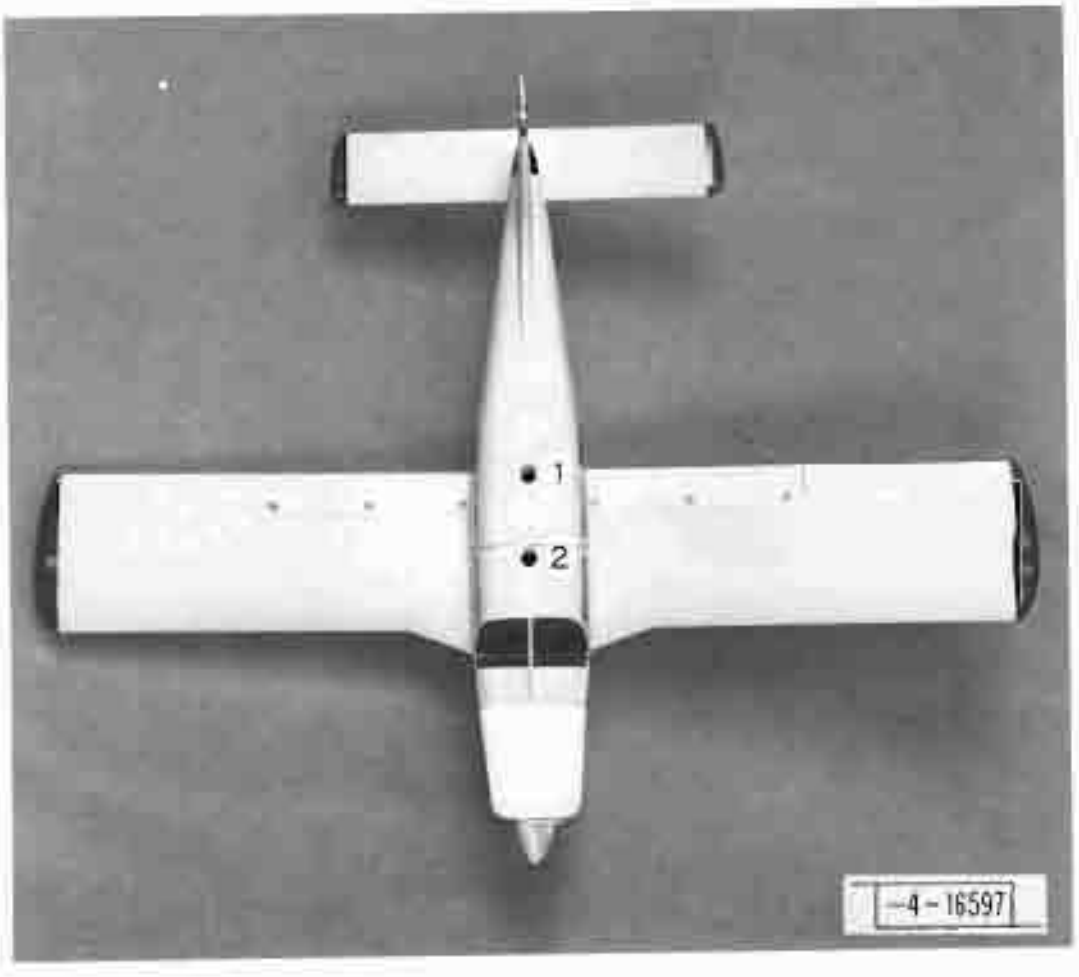

Fig. 1-6. Piper Cherokee Arrow, top view showing antenna positions 1 and 2.

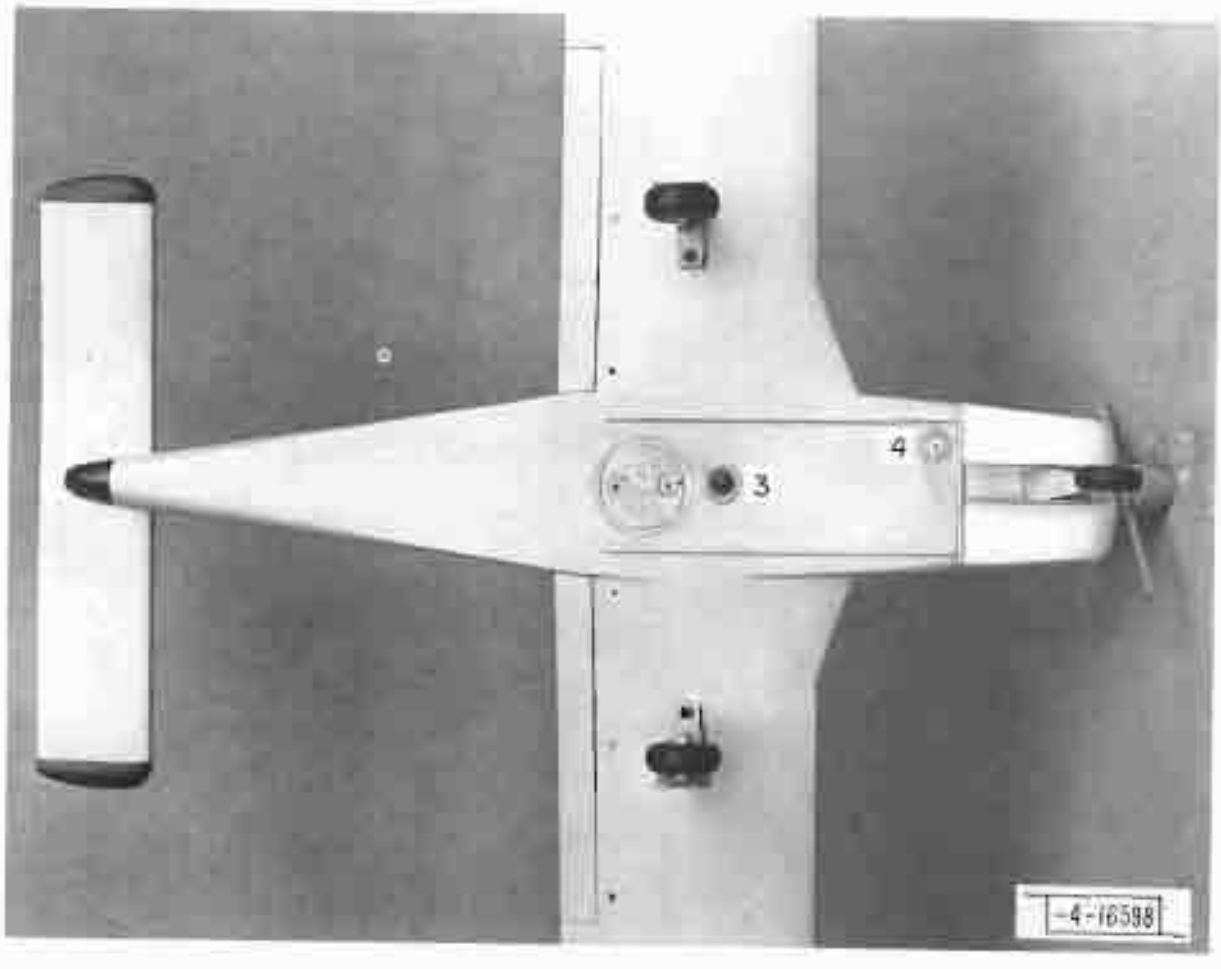

Fig. 1-7. Piper Cherokee Arrow, bottom view showing antenna positions 3 and 4.

Fig. 1-8. Helio U10D, three-quarter view.

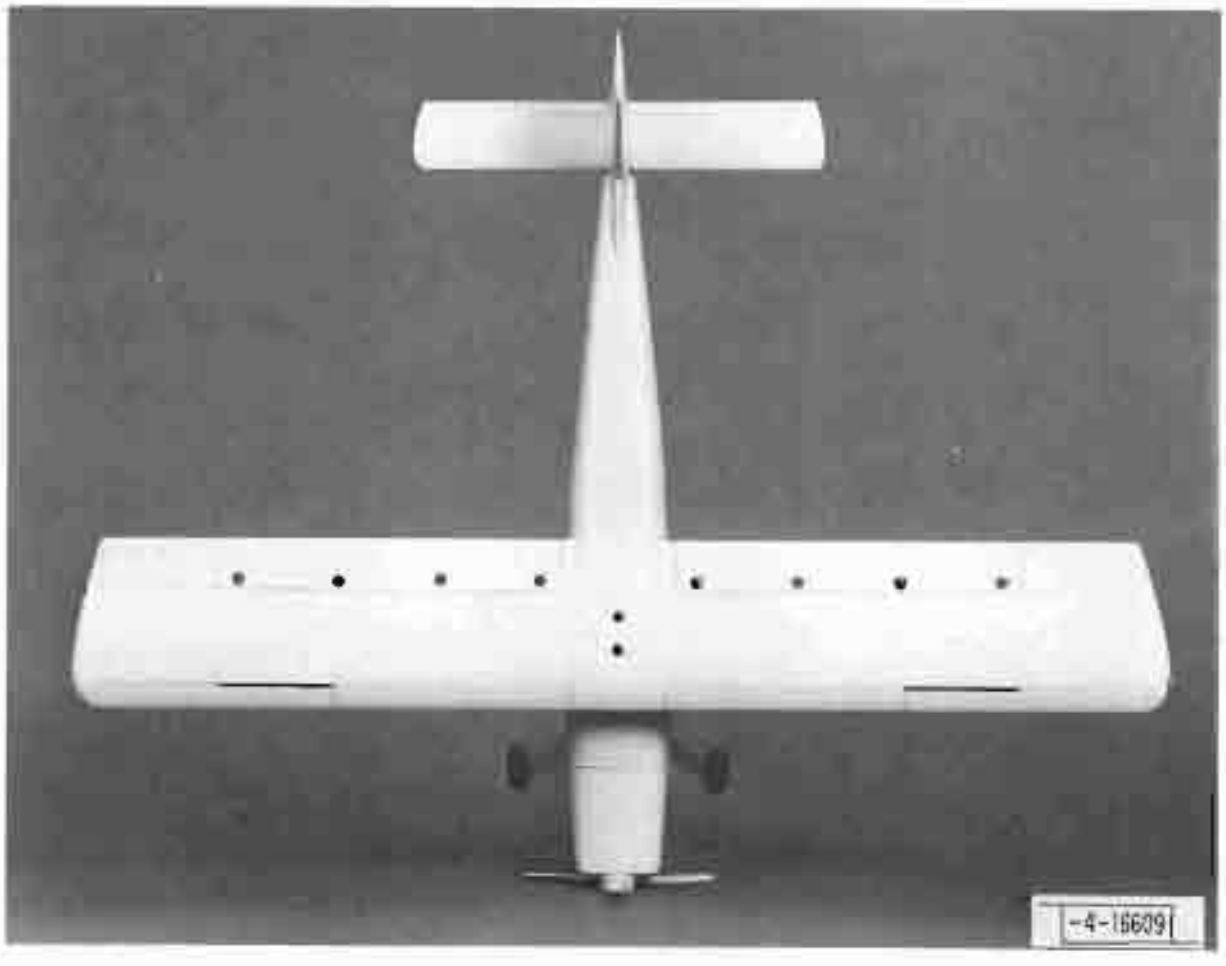

Fig. 1-9. Helio U10D, top view.

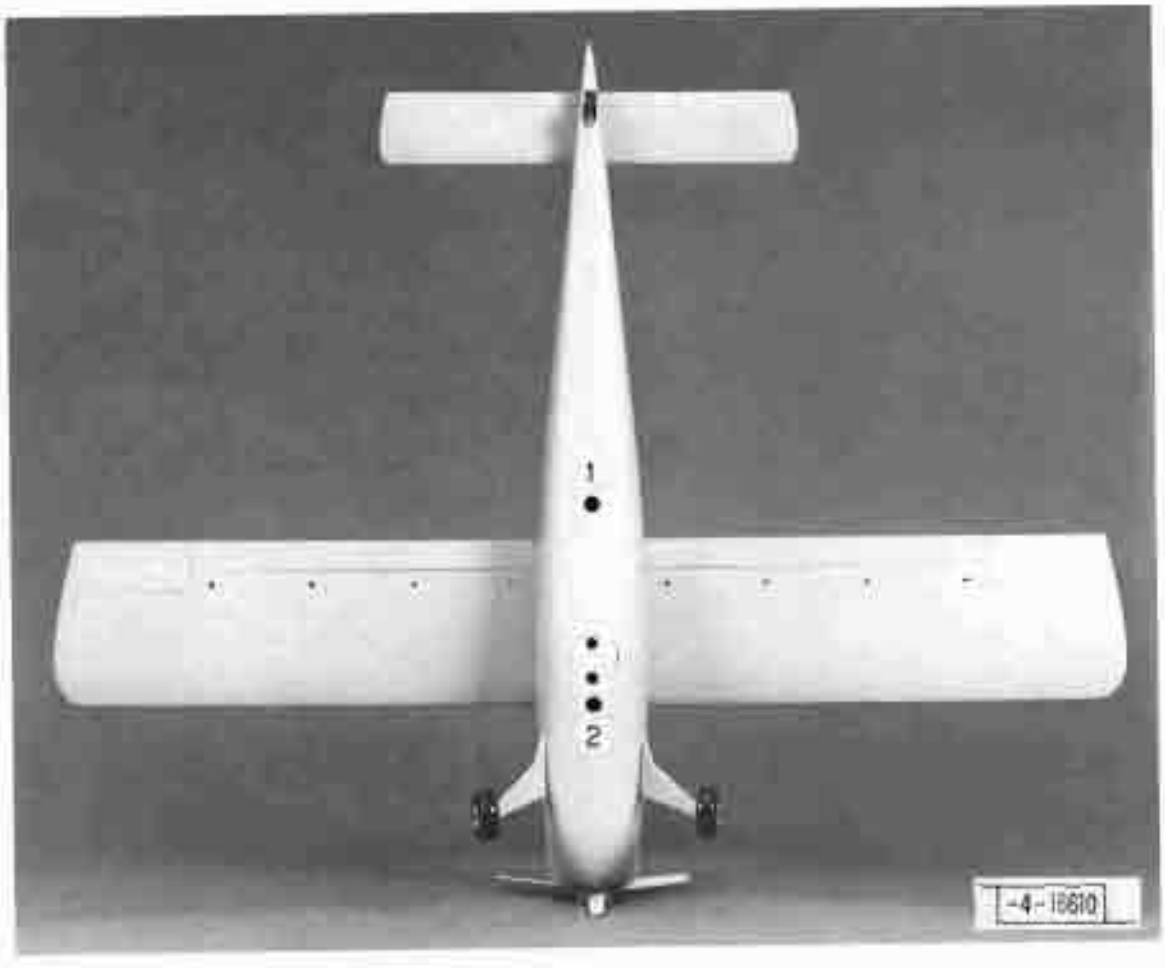

Fig. 1-10. Helio U10D, bottom view showing antenna positions 1 and 2.

Fig. 1-11. Beechcraft Baron, three-quarter view.

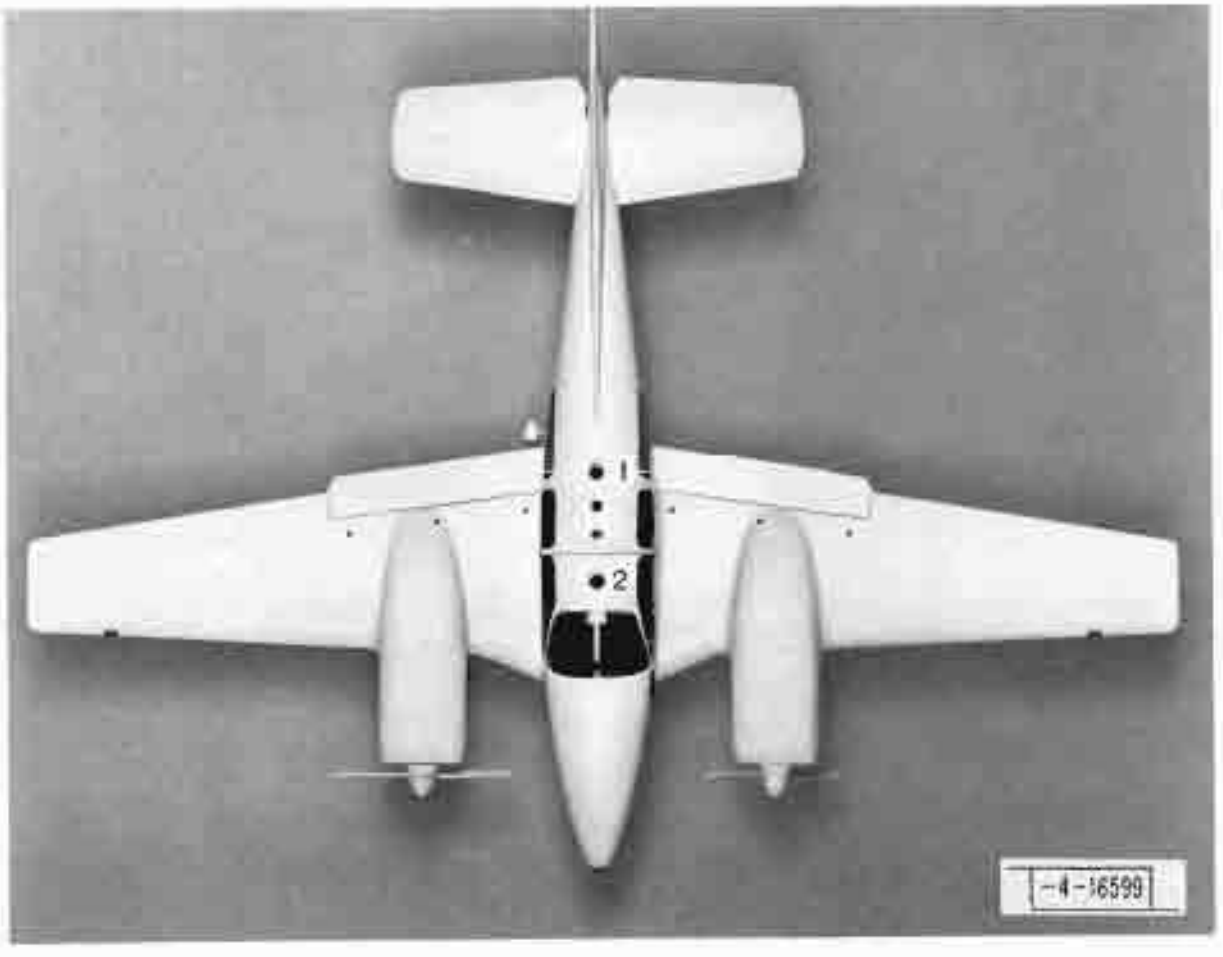

Fig. 1-12. Beechcraft Baron, top view showing antenna positions 1 and 2.

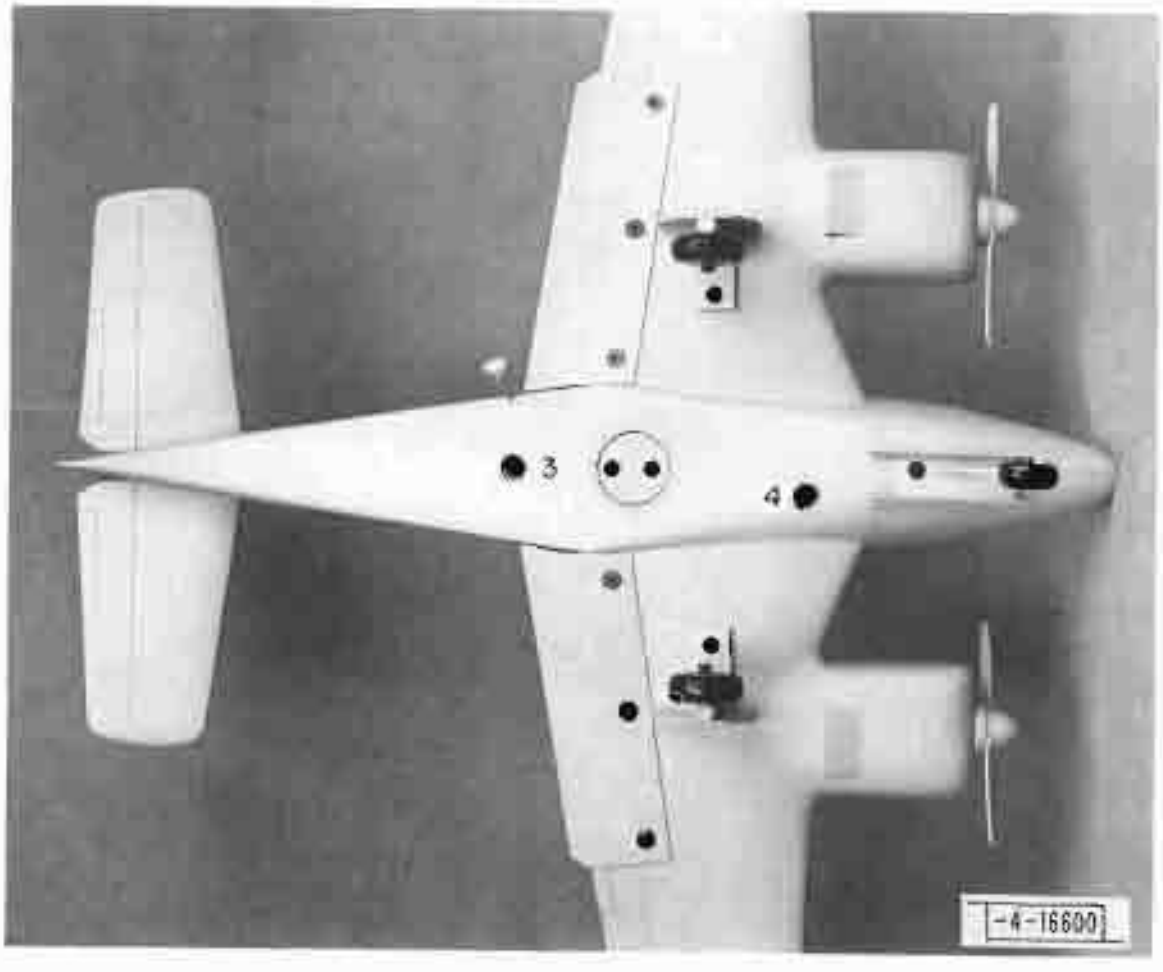

Fig. 1-13. Beechcraft Baron, bottom view showing antenna positions 3 and 4.

Fig. 1-14. Beechcraft B99, three-quarter view.

Fig. 1-15. Beechcraft B99, top view showing antenna positions 1 and 2.

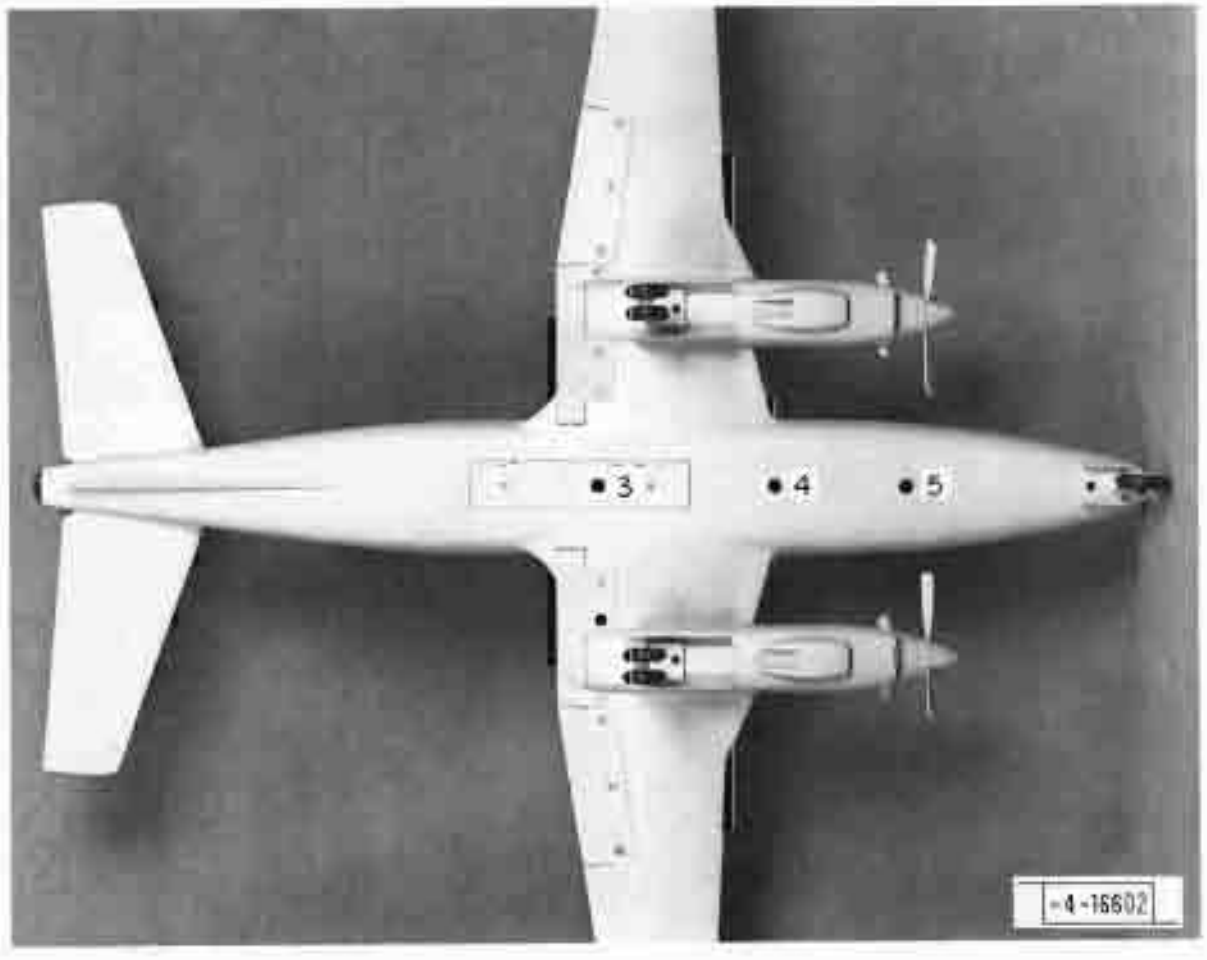

Fig. 1-16. Beechcraft B99, bottom view showing antenna positions 3, 4 and 5.

Fig. 1-17. Gates Lear Jet, three-quarter view.

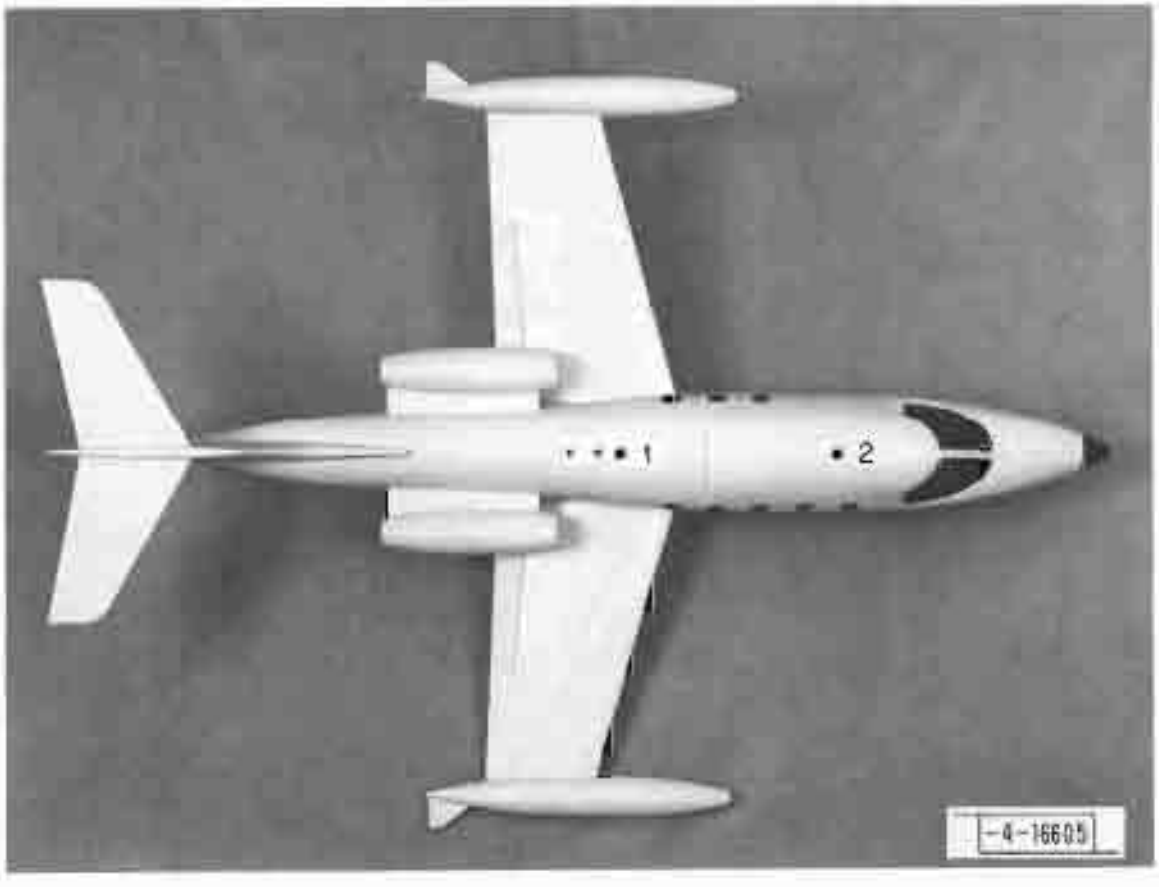

Fig. I-18. Gates Lear Jet, top view showing antenna positions 1 and 2.

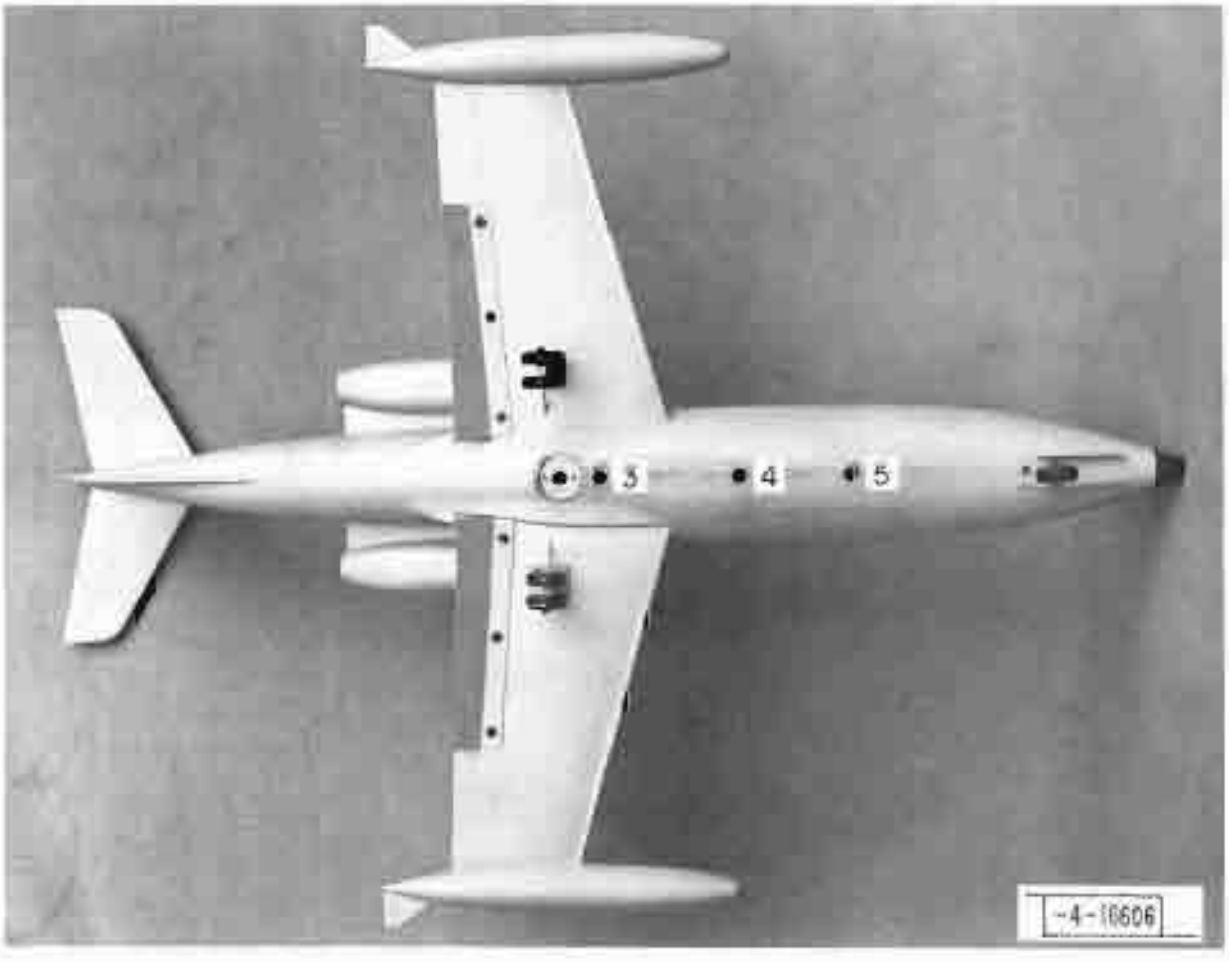

Fig. 1-19. Gates Lear Jet, bottom view showing antenna positions 3, 4 and 5.

Fig. 1-20. Grumman Gulfstream, three-quarter view.

Fig. 1-21. Grumman Gulfstream, top view showing antenna positions 1 and 2.

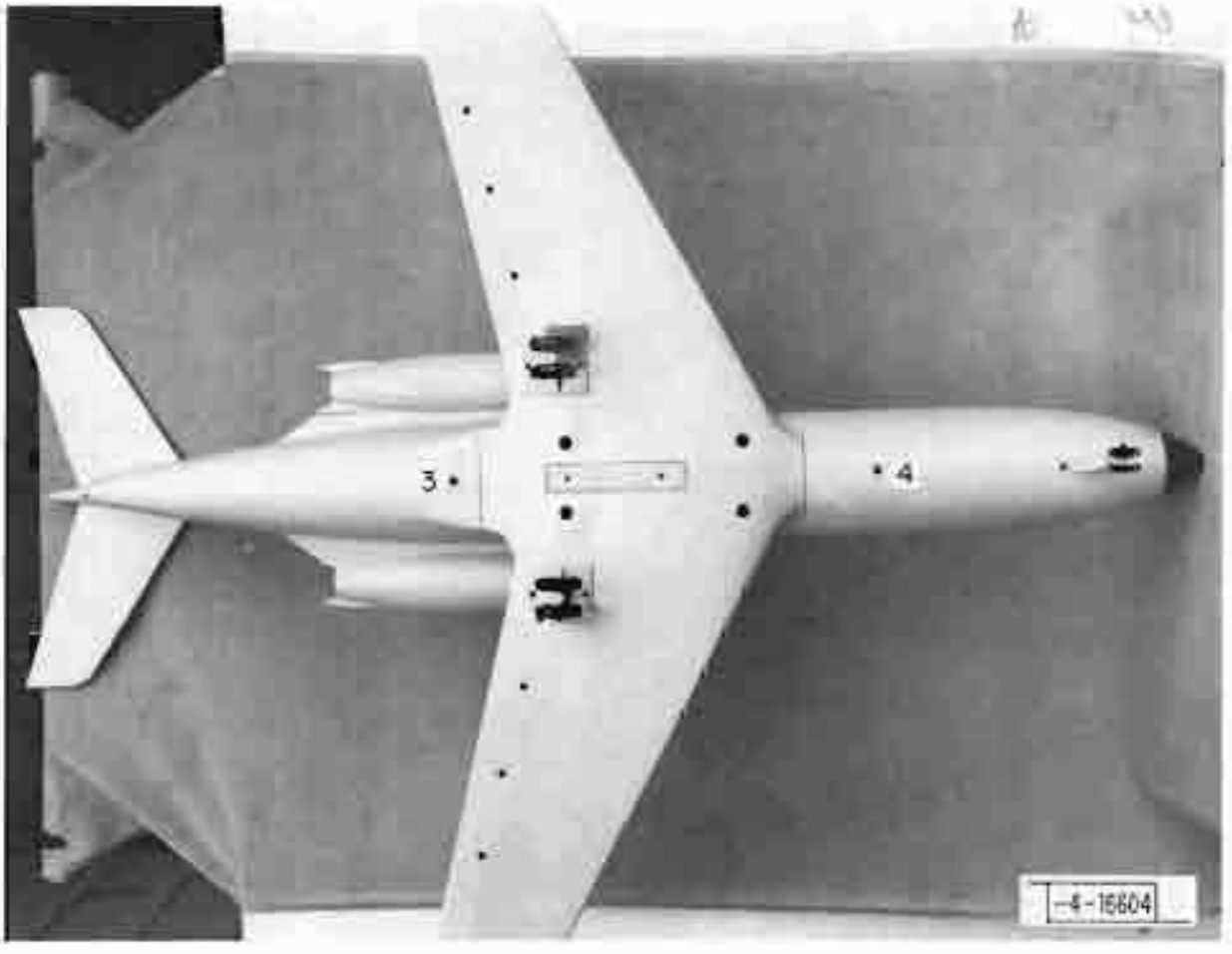

Fig. 1-22. Grumman Gulfstream, bottom view showing antenna positions 3 and 4.

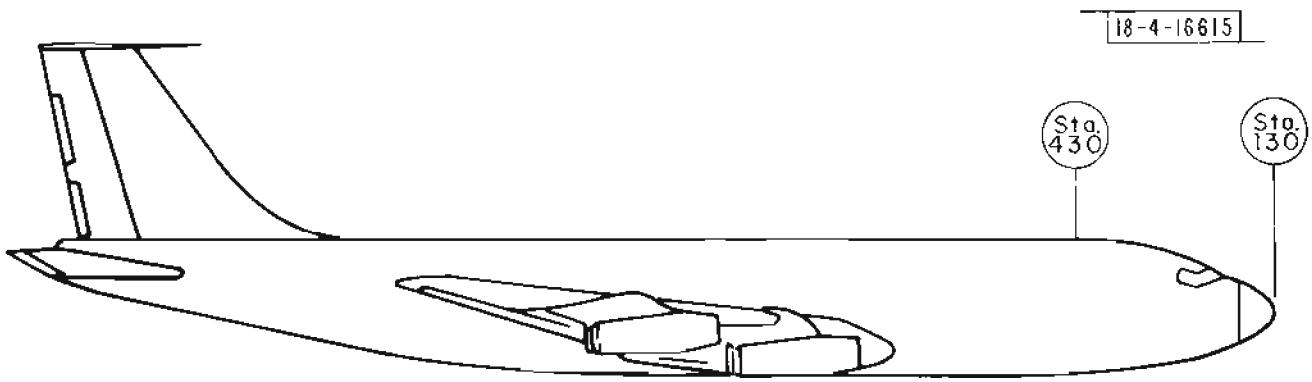

Fig. 1-23(a). Boeing 707, side view showing station position of antennas 1 and 2.

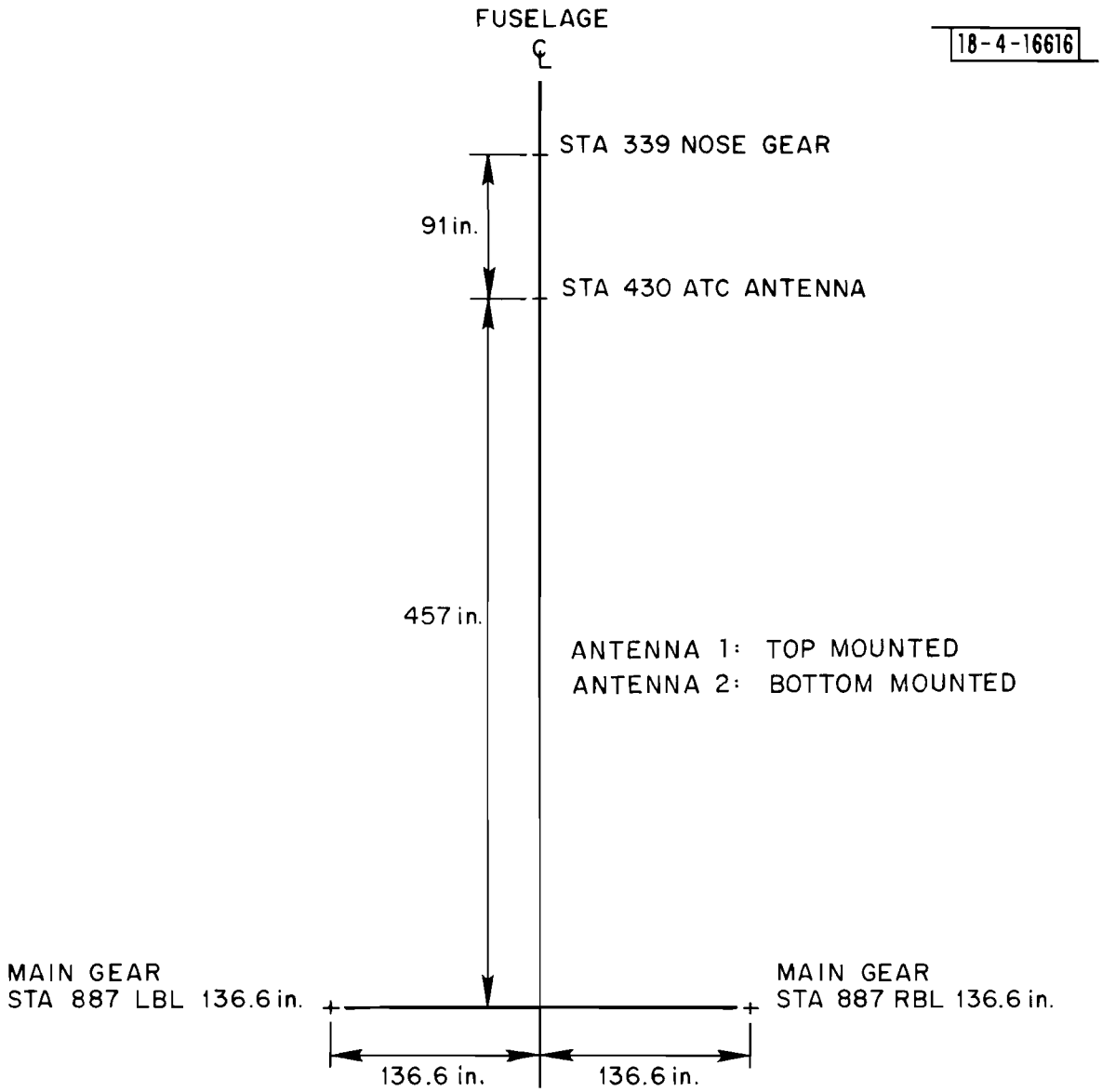

Fig. 1-23(b). Boeing 707, relative positions of landing gear to antenna station.

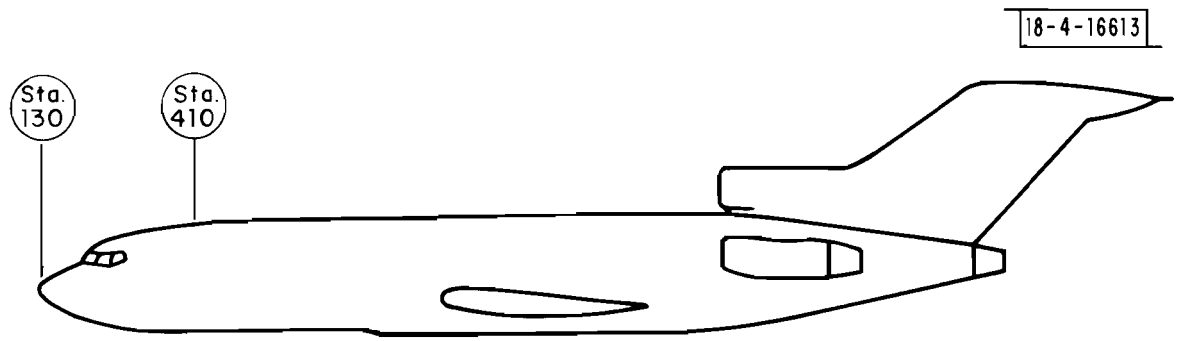

Fig. 1-24(a). Boeing 727, side view showing station position of antennas 1 and 2.

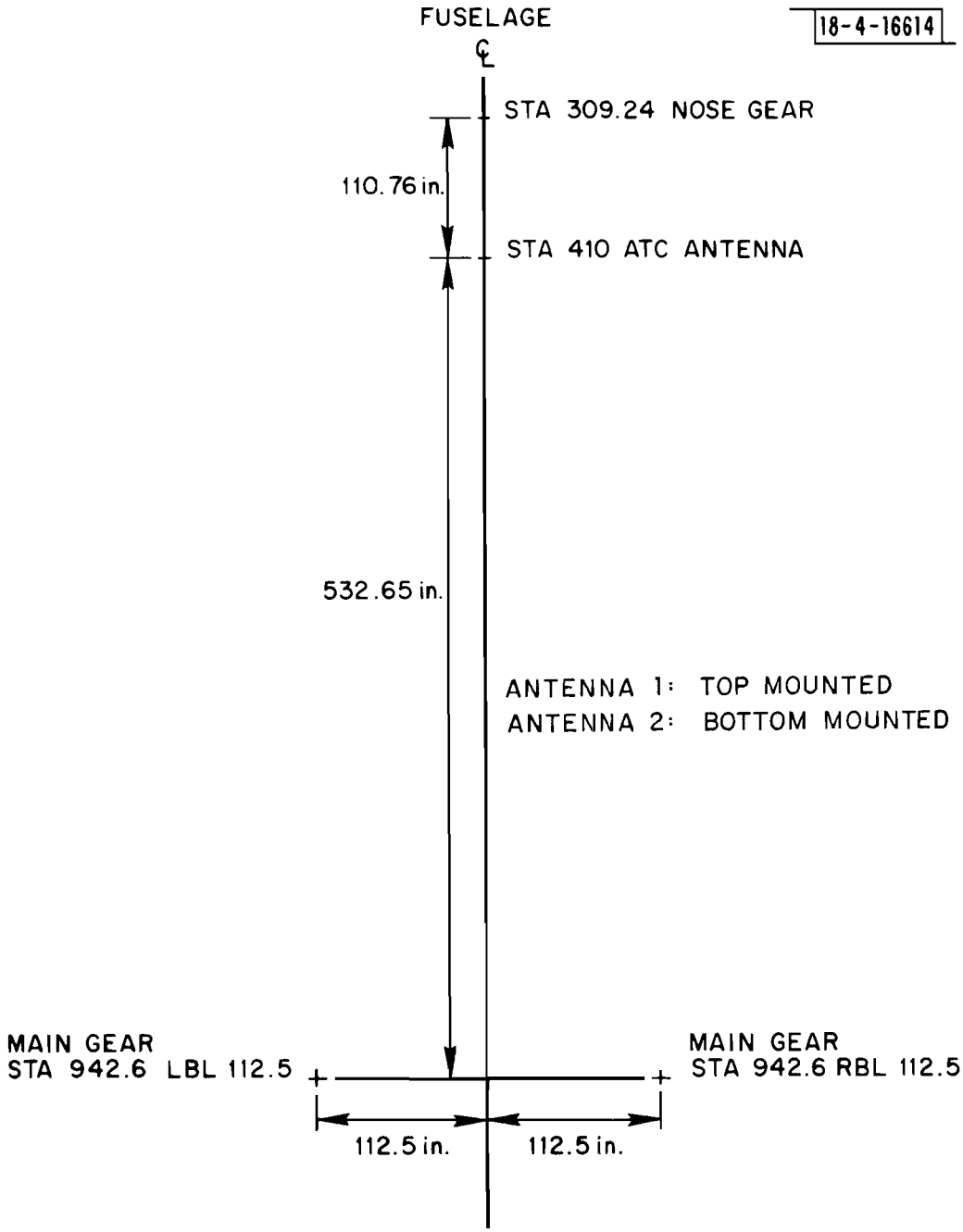

Fig. 1-24(b). Boeing 727, relative positions of landing gear to antenna station.

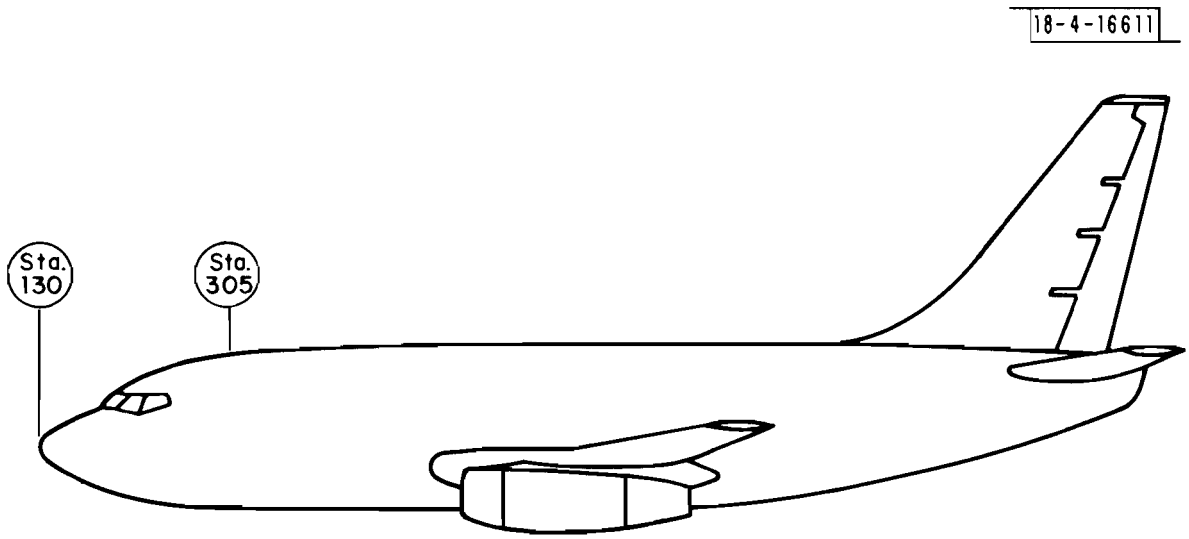

Fig. 1-25(a). Boeing 737, side view showing station position of antennas 1 and 2.

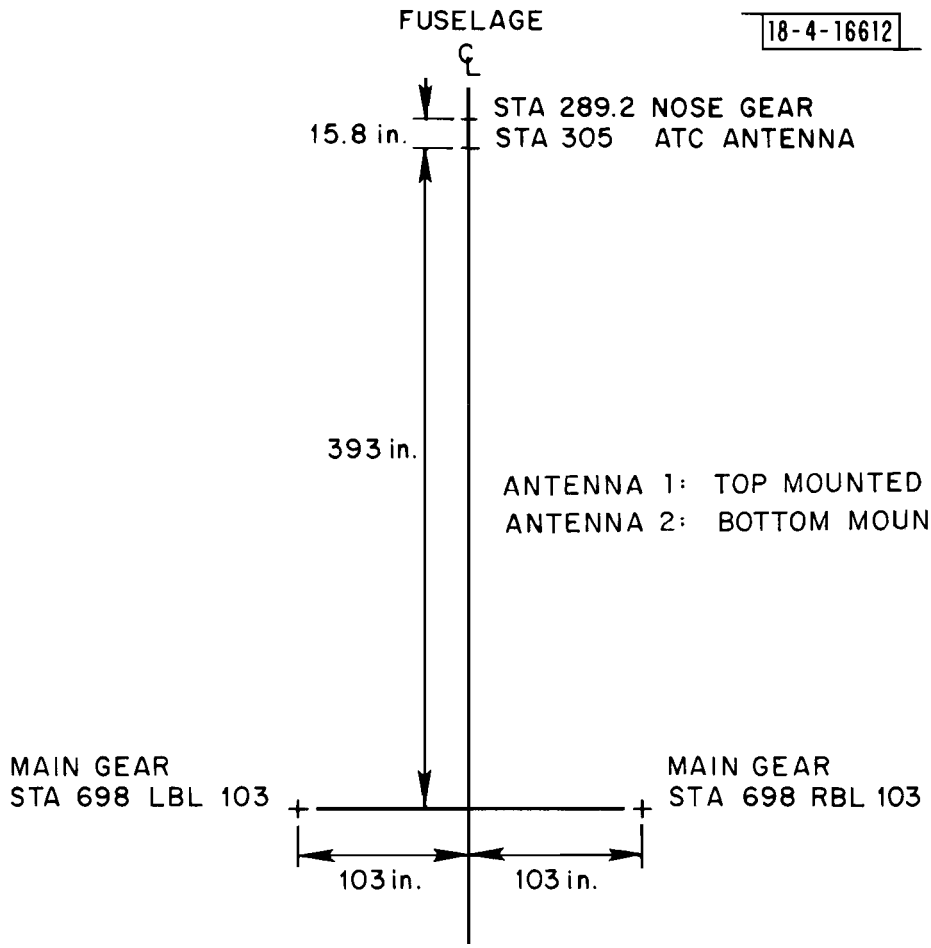

Fig. 1-25(b). Boeing 737, relative position of landing gear to antenna station.

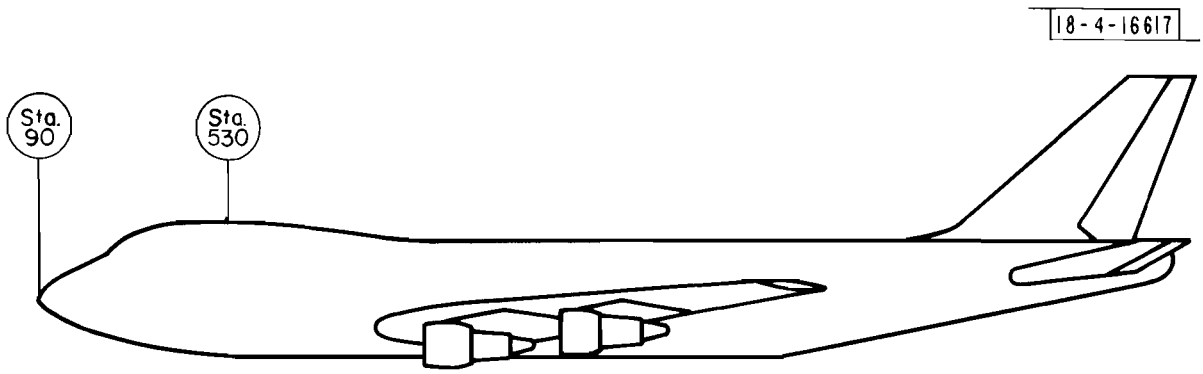

Fig. 1-26(a). Boeing 747, side view showing station position of antennas 1 and 2.

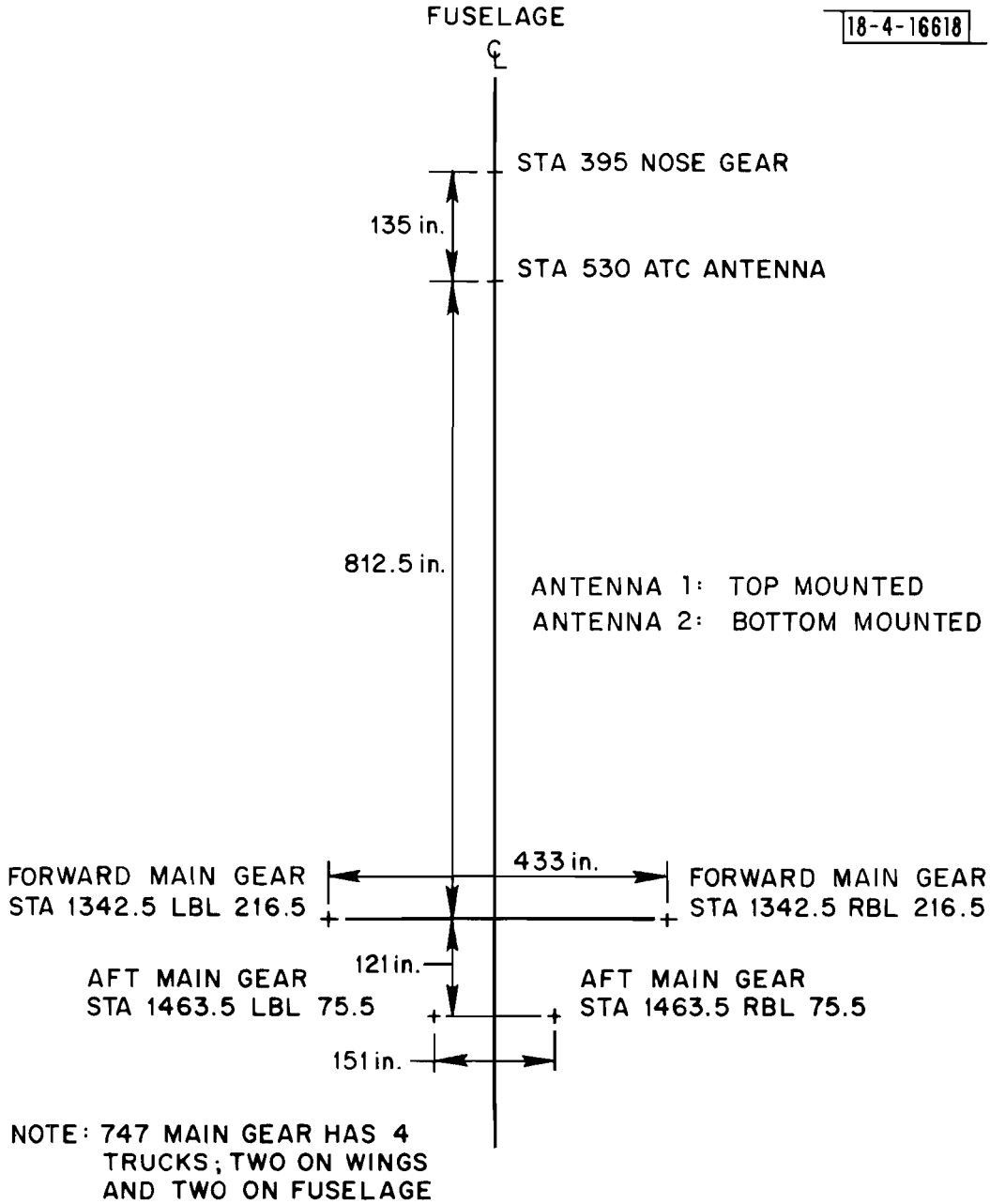

Fig. 1-26(b). Boeing 747, relative positions of landing gear to antenna station.

VI. Aircraft Antenna Maps

GENERAL AVIATION

1. Single Engine
   (a) Cessna 150
   (b) Piper Cherokee Arrow
   (c) Helio U10D
2. Twin Engine
   (a) Beechcraft Baron
   (b) Beechcraft Baron 99
3. Small Jets
   (a) Gates Lear
   (b) Grumman Gulfstream

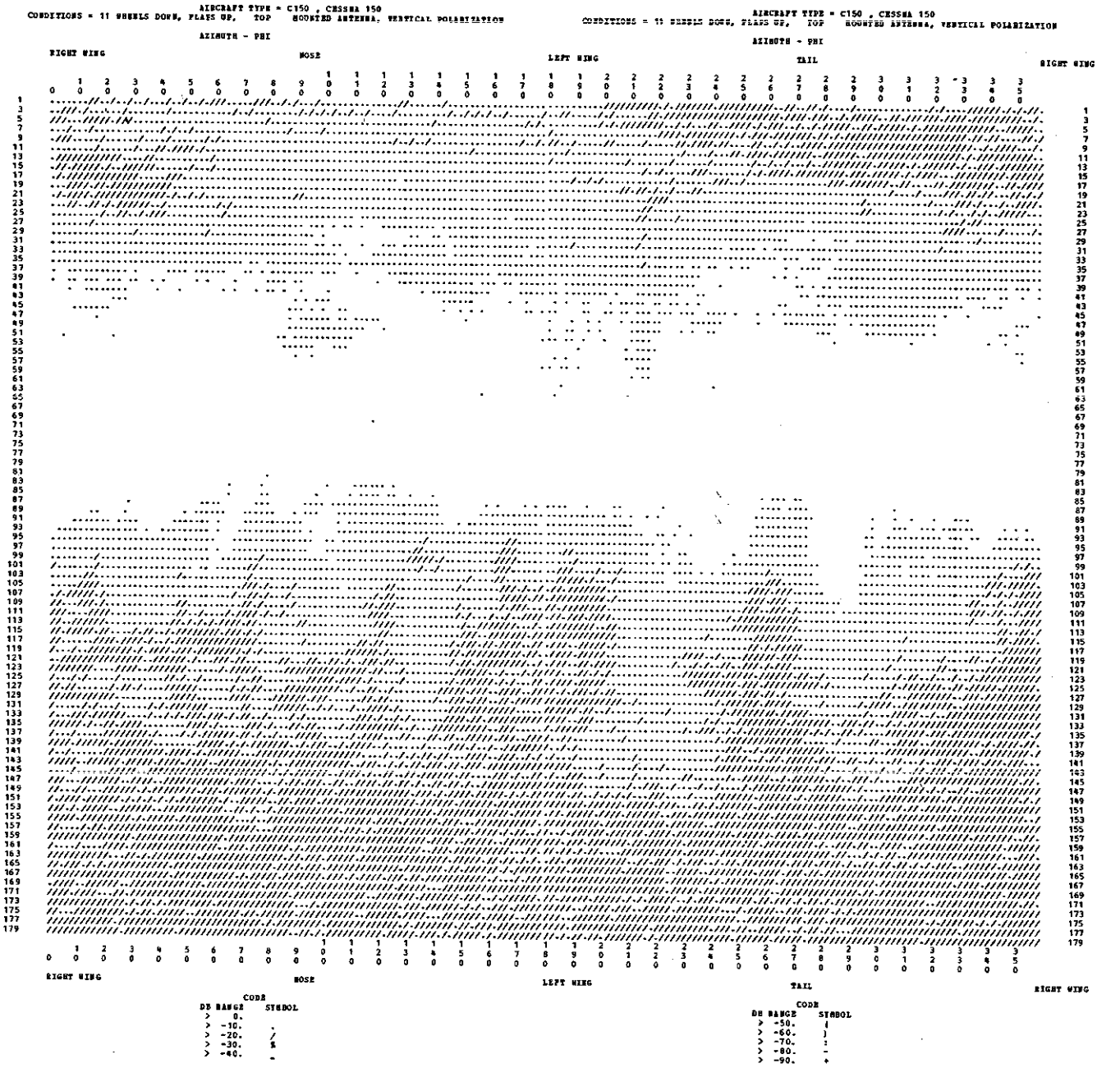

Fig. 2-1. Cessna 150; antenna position 1 (T); wheels down, flaps up.

C45-1215

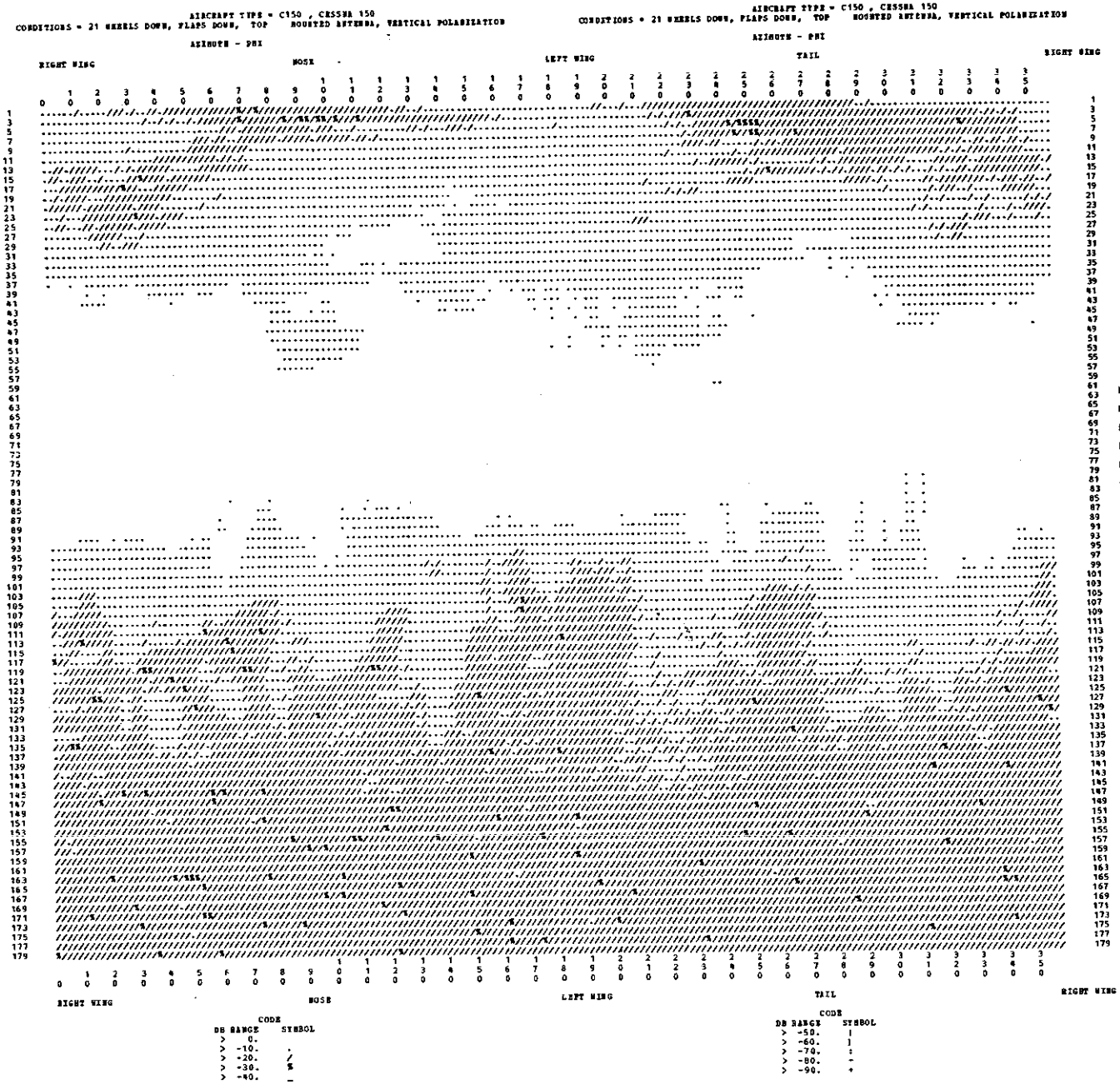

Fig. 2-2. Cessna 150; antenna position 1(T); wheels down, flaps down.

C45-1216

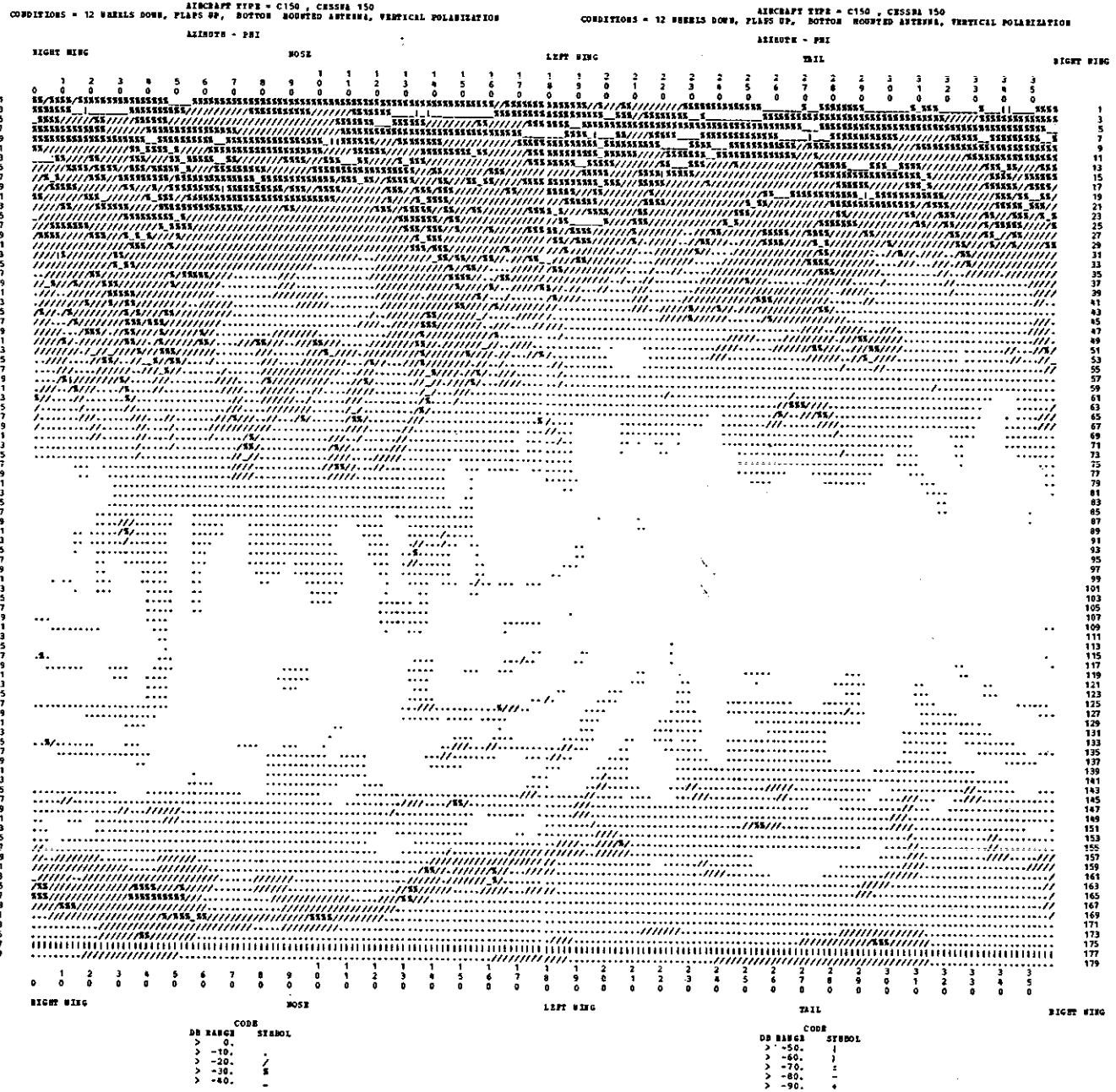

Fig. 2-3. Cessna 150; antenna position 2 (B); wheels down, flaps up.

C45-1217

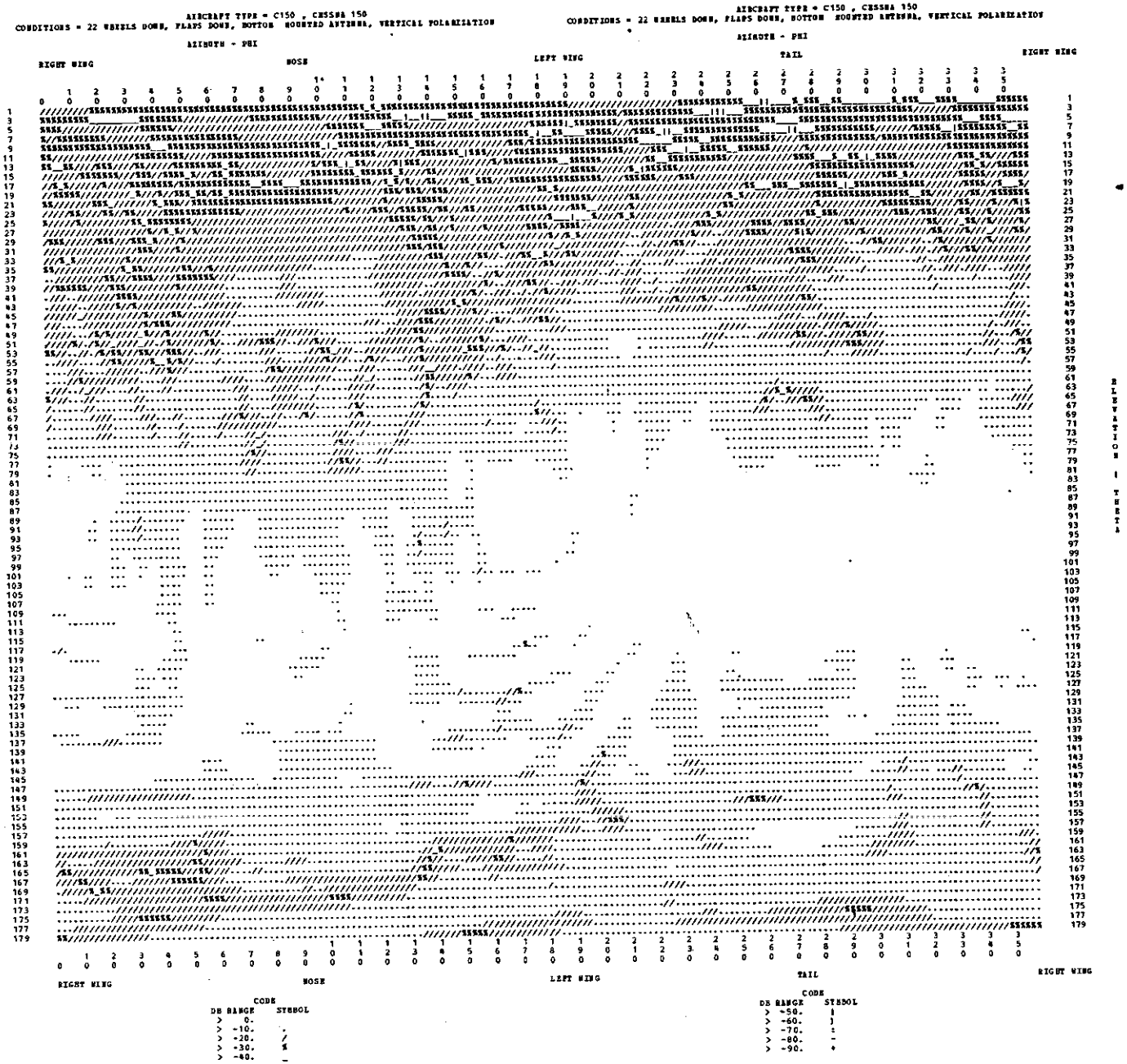

Fig. 2-4. Cessna 150; antenna position 2 (B); wheels down, flaps down.

C45-1218

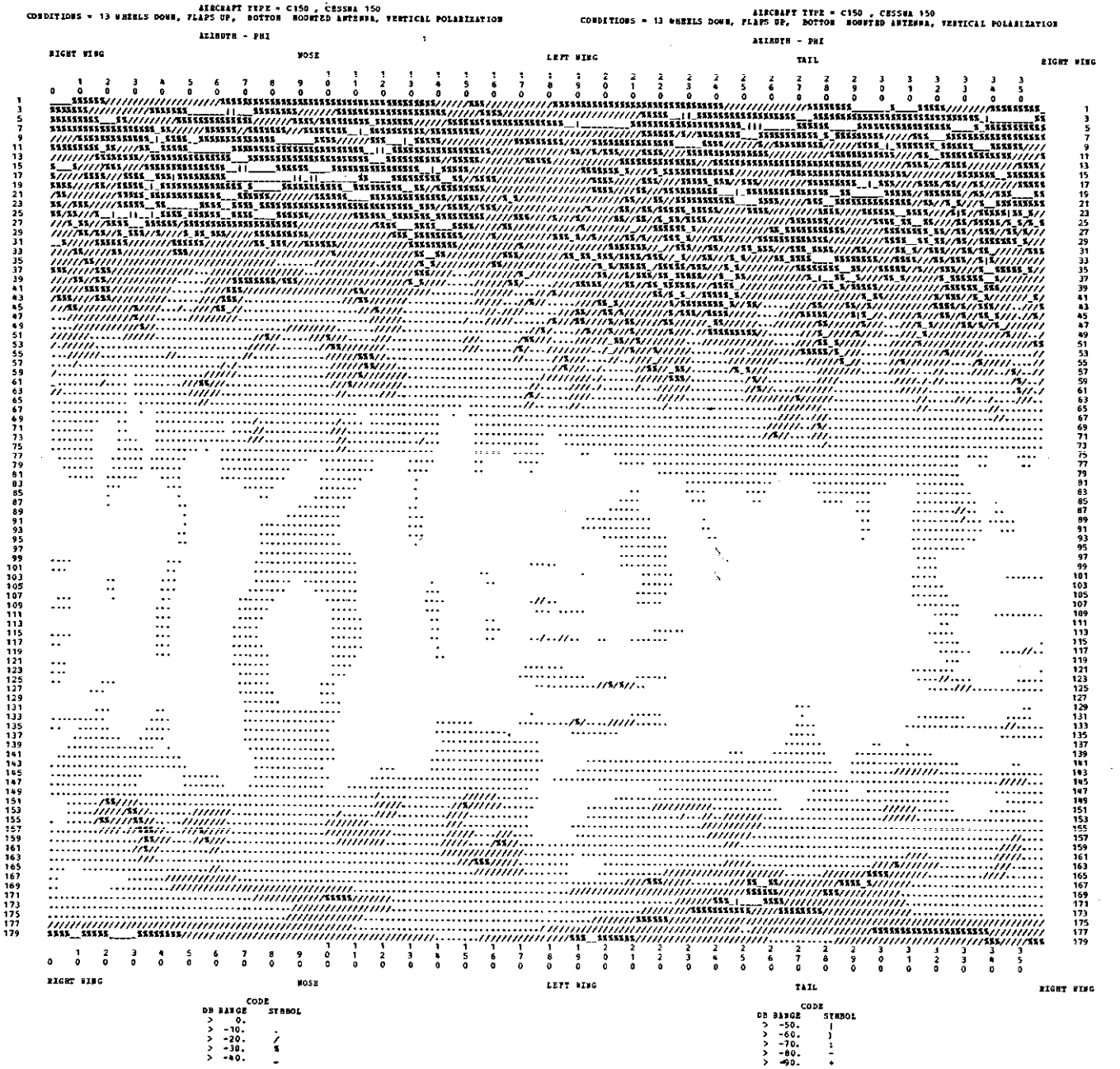

Fig. 2-5. Cessna 150; antenna position 3 (B); wheels down, flaps up.

C45-1219

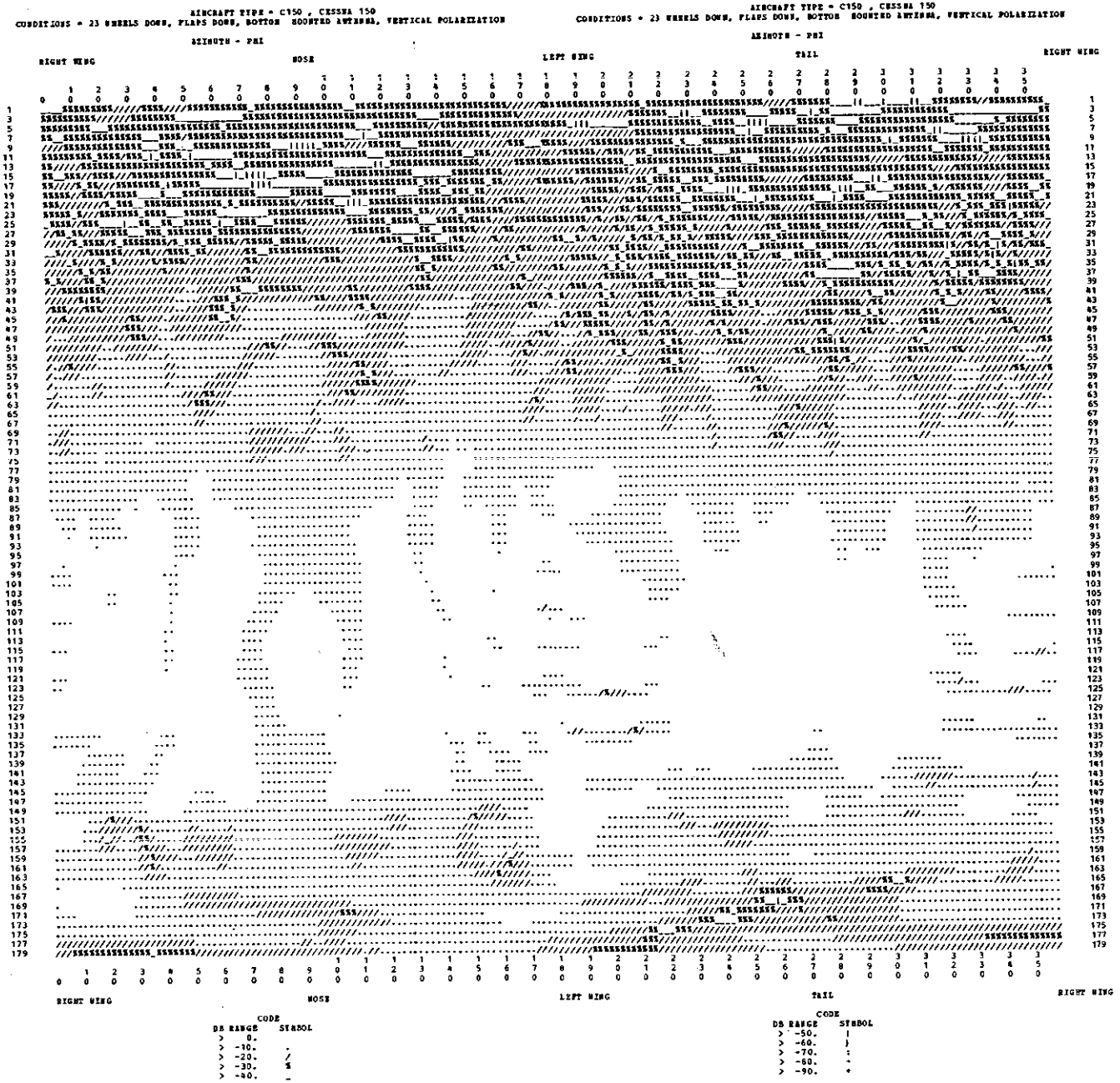

Fig. 2-6. Cessna 150; antenna position 3 (B); wheels down, flaps down.

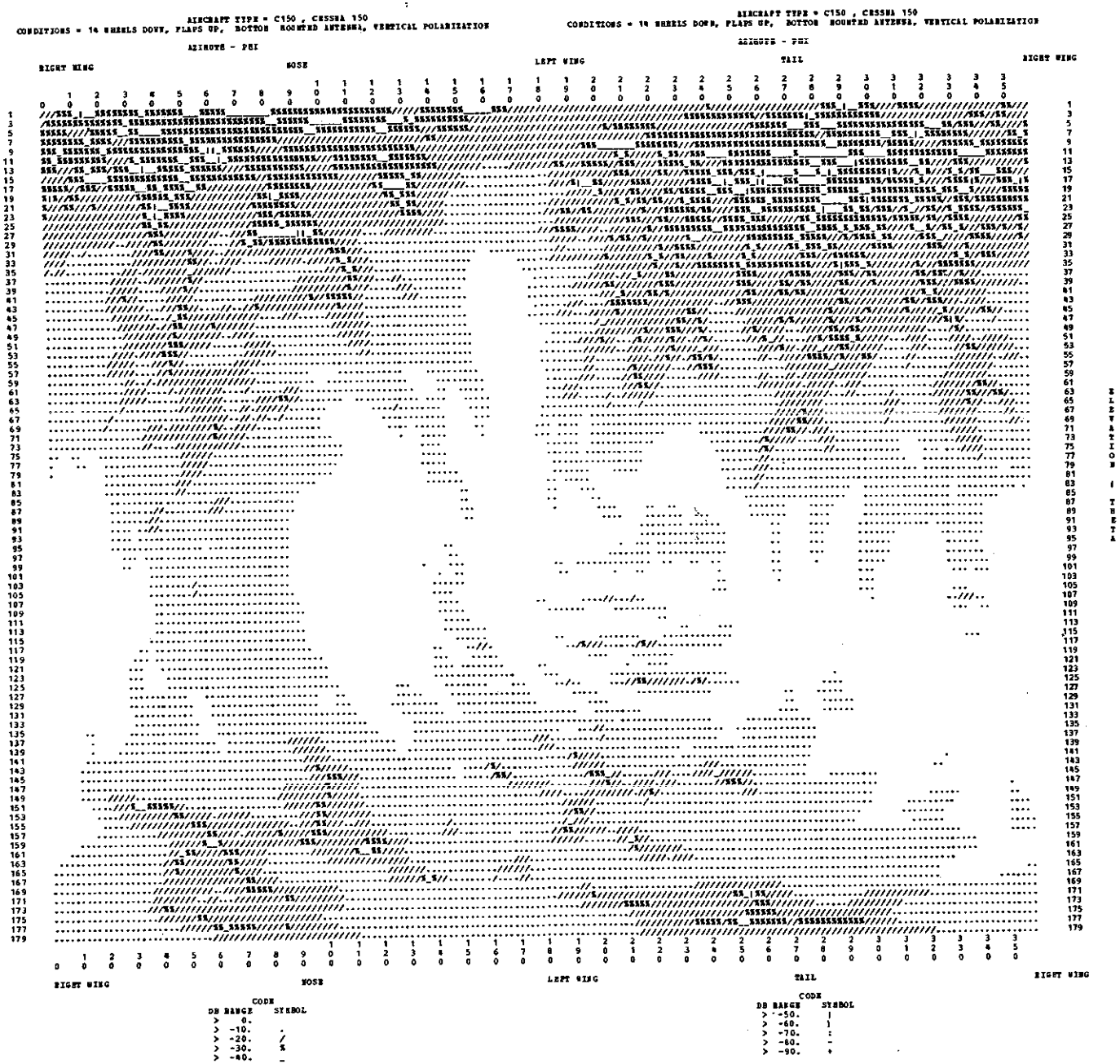

Fig. 2-7. Cessna 150; antenna position 4 (B); wheels down, flaps up.

C45-1223

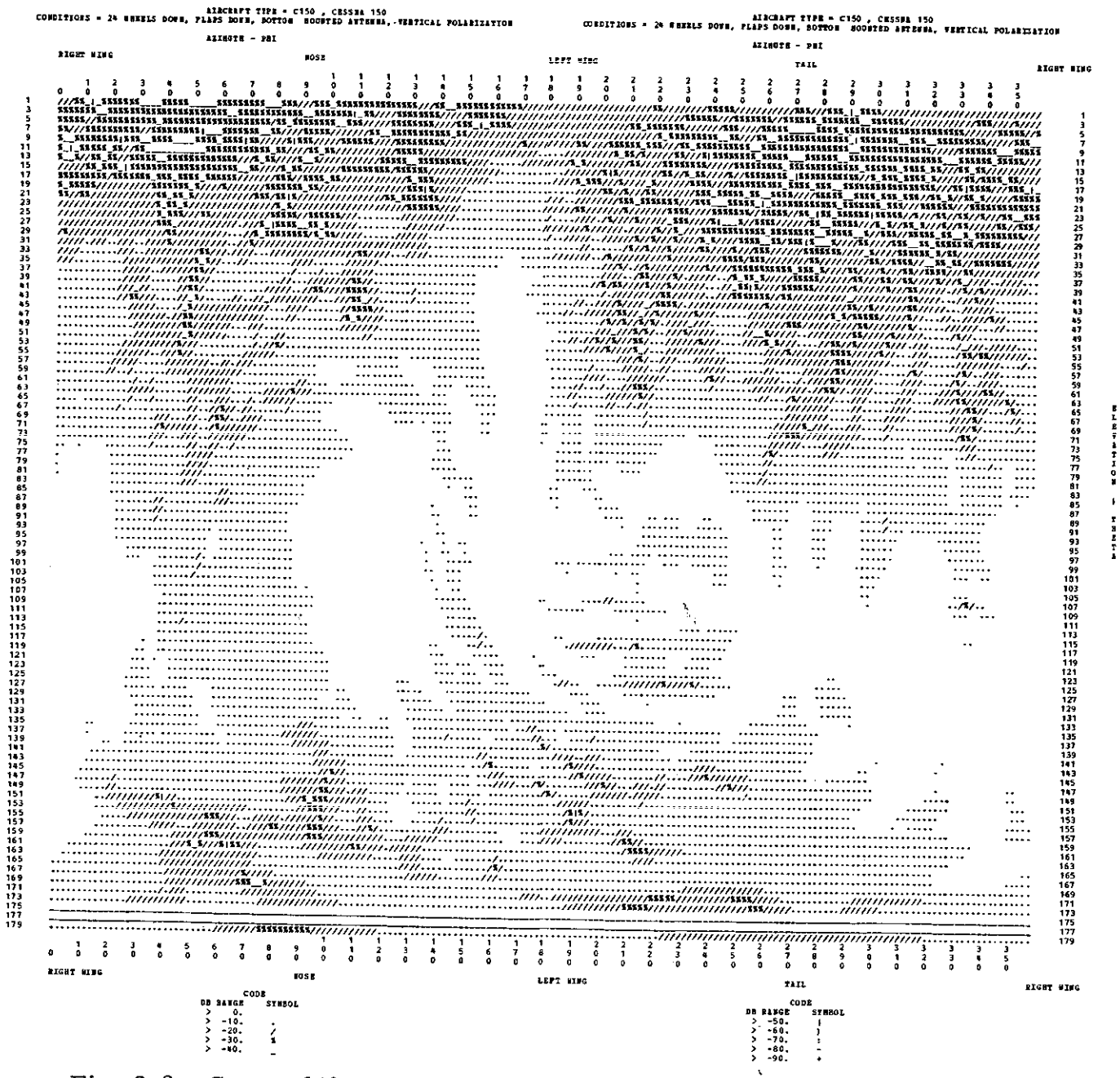

Fig. 2-8. Cessna 150; antenna position 4 (B); wheels down, flaps down.

C45-1222

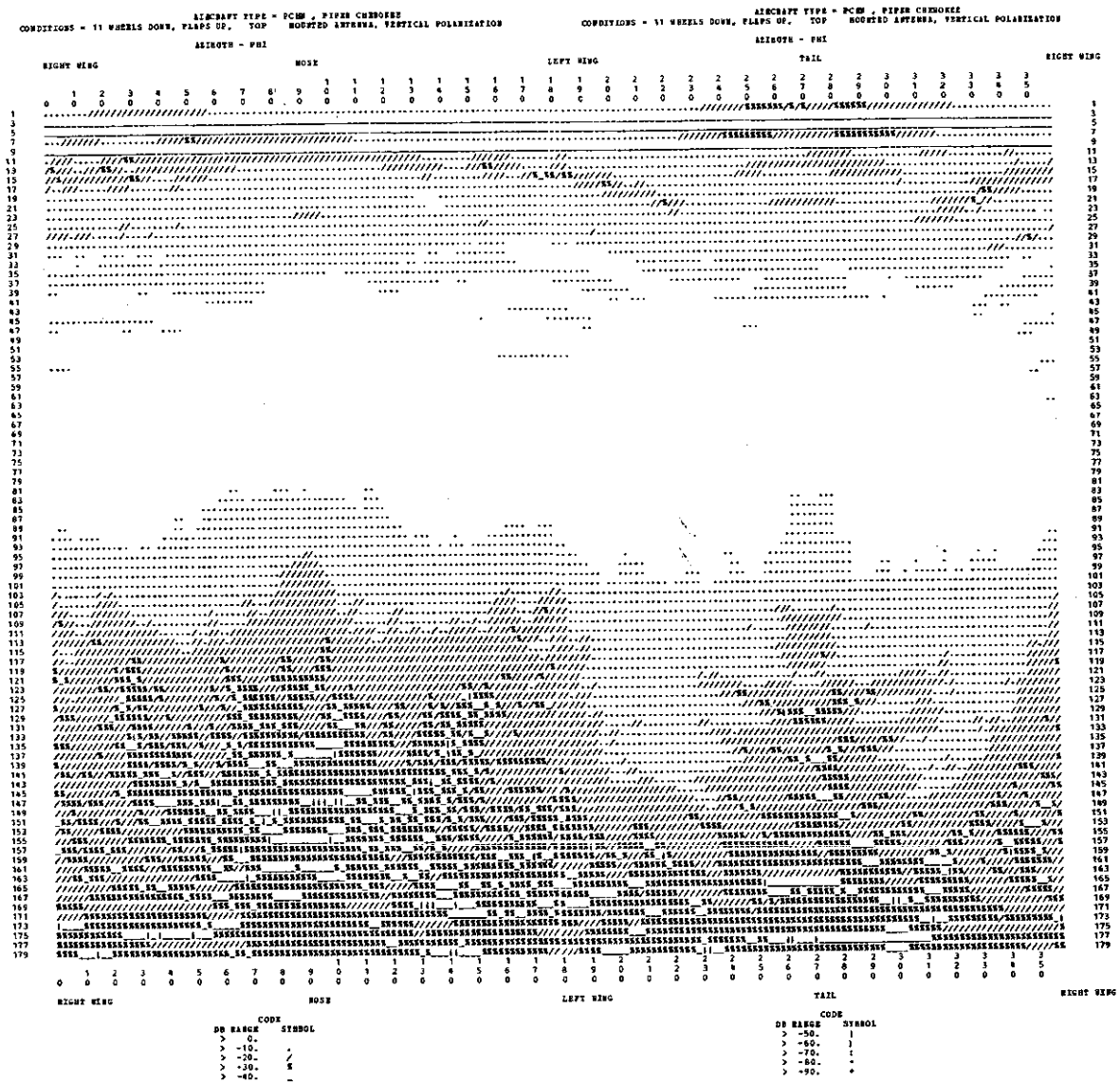

Fig. 3-1. Piper Cherokee Arrow; antenna position 1 (T); wheels down, flaps up.

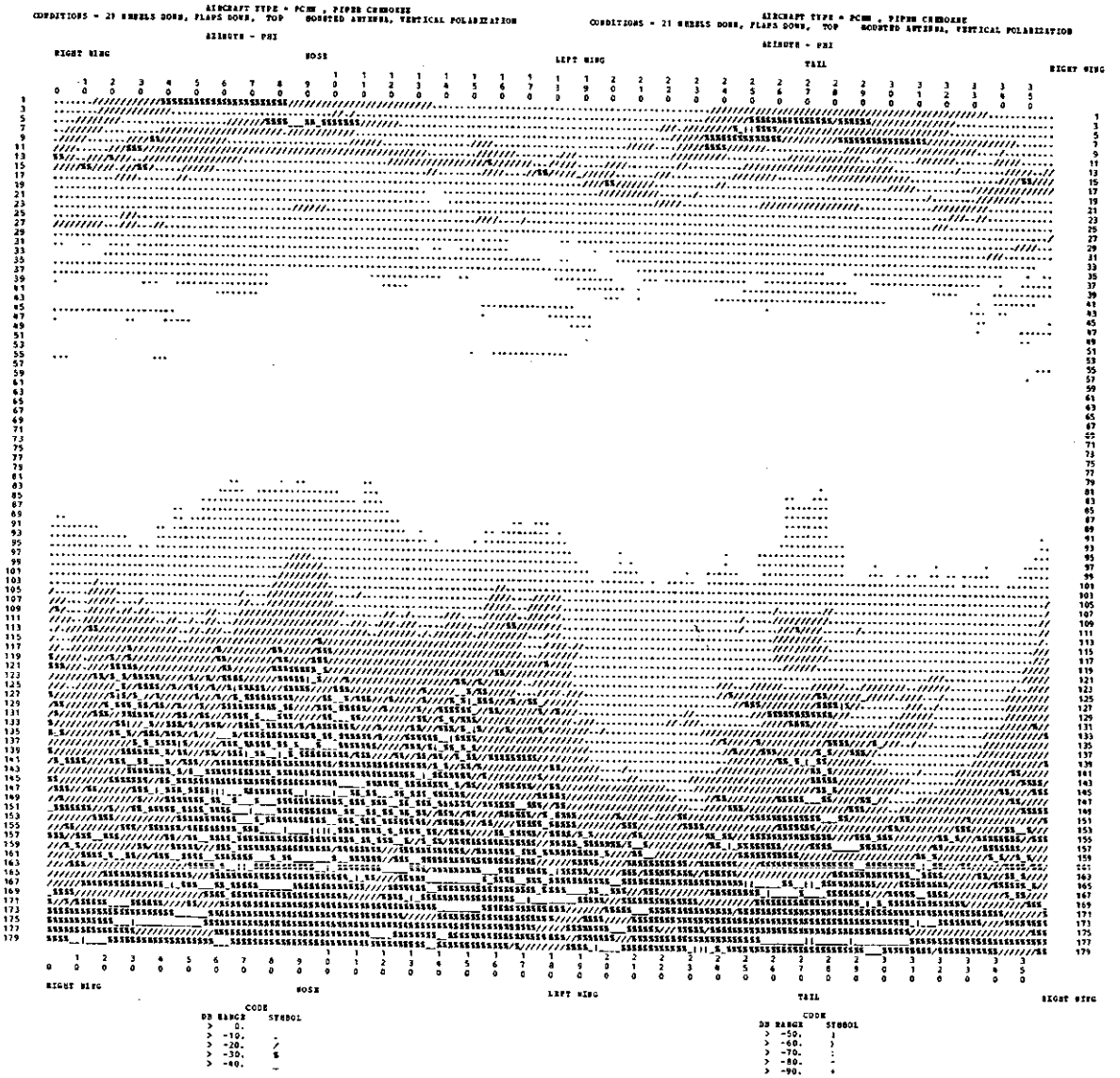

Fig. 3-2. Piper Cherokee Arrow; antenna position 1 (T); wheels down, flaps down.

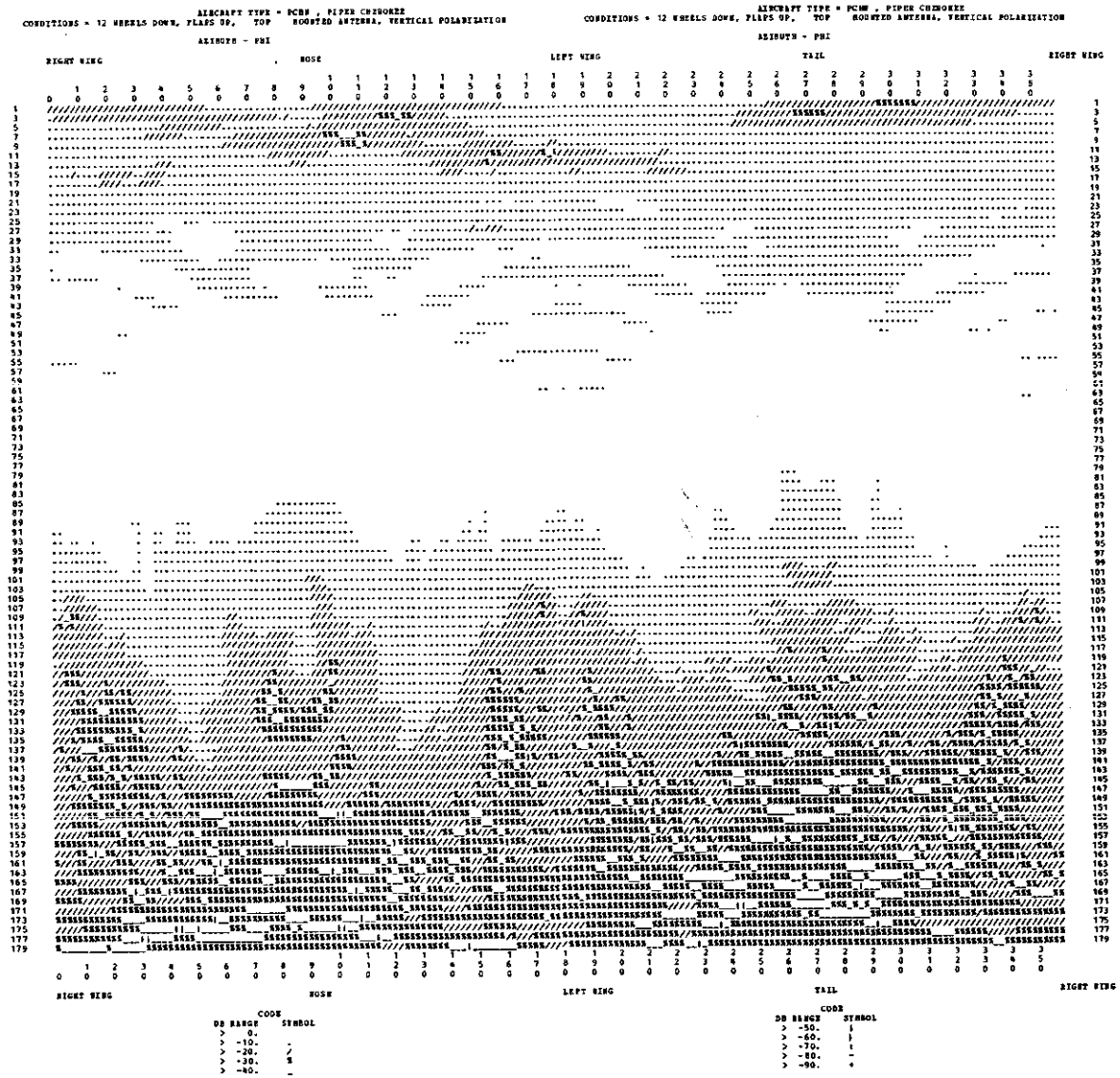

Fig. 3-3. Piper Cherokee Arrow; antenna position 2 (T); wheels down, flaps up.

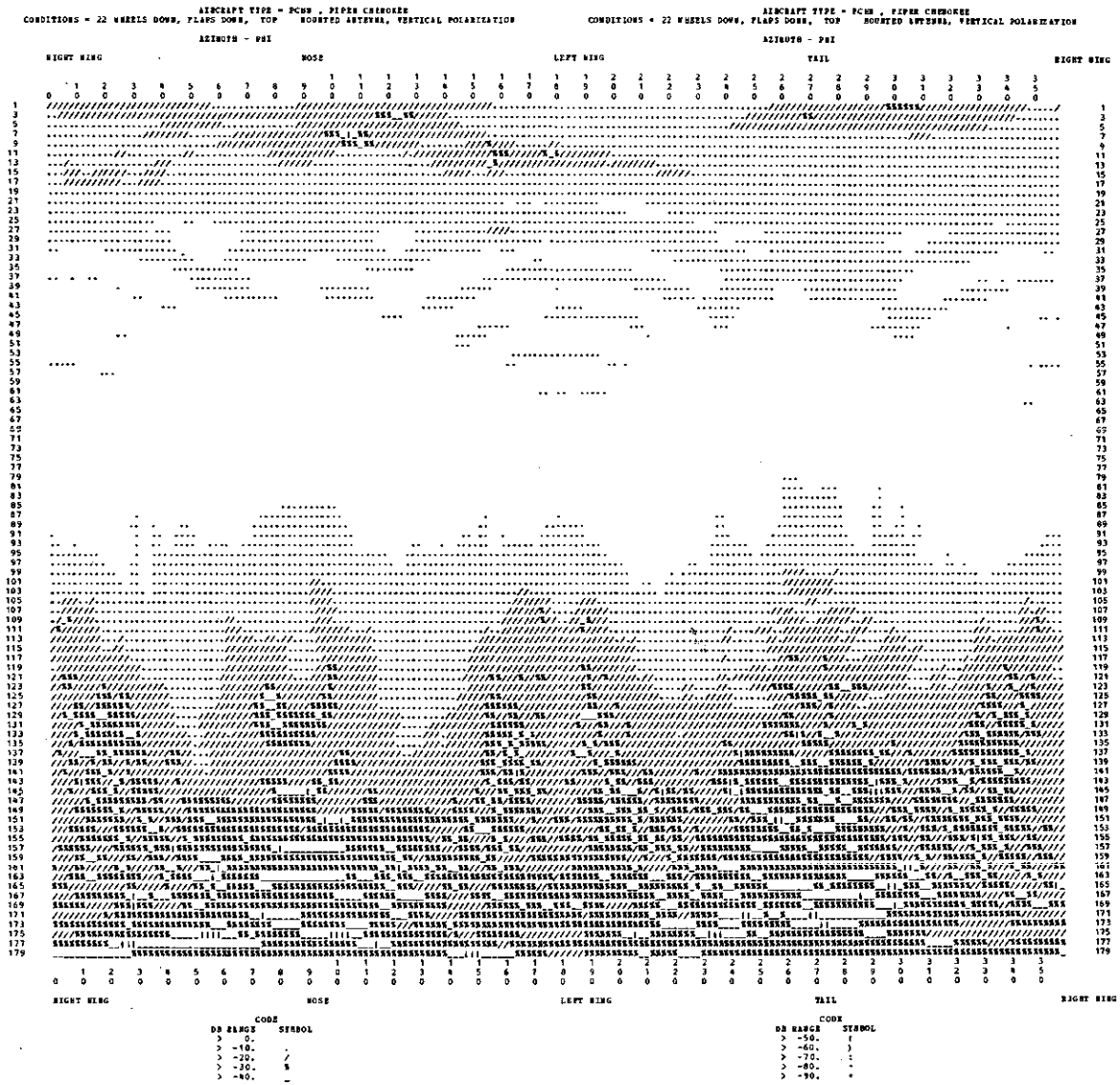

Fig. 3-4. Piper Cherokee Arrow; antenna position 2 (T); wheels down, flaps down.

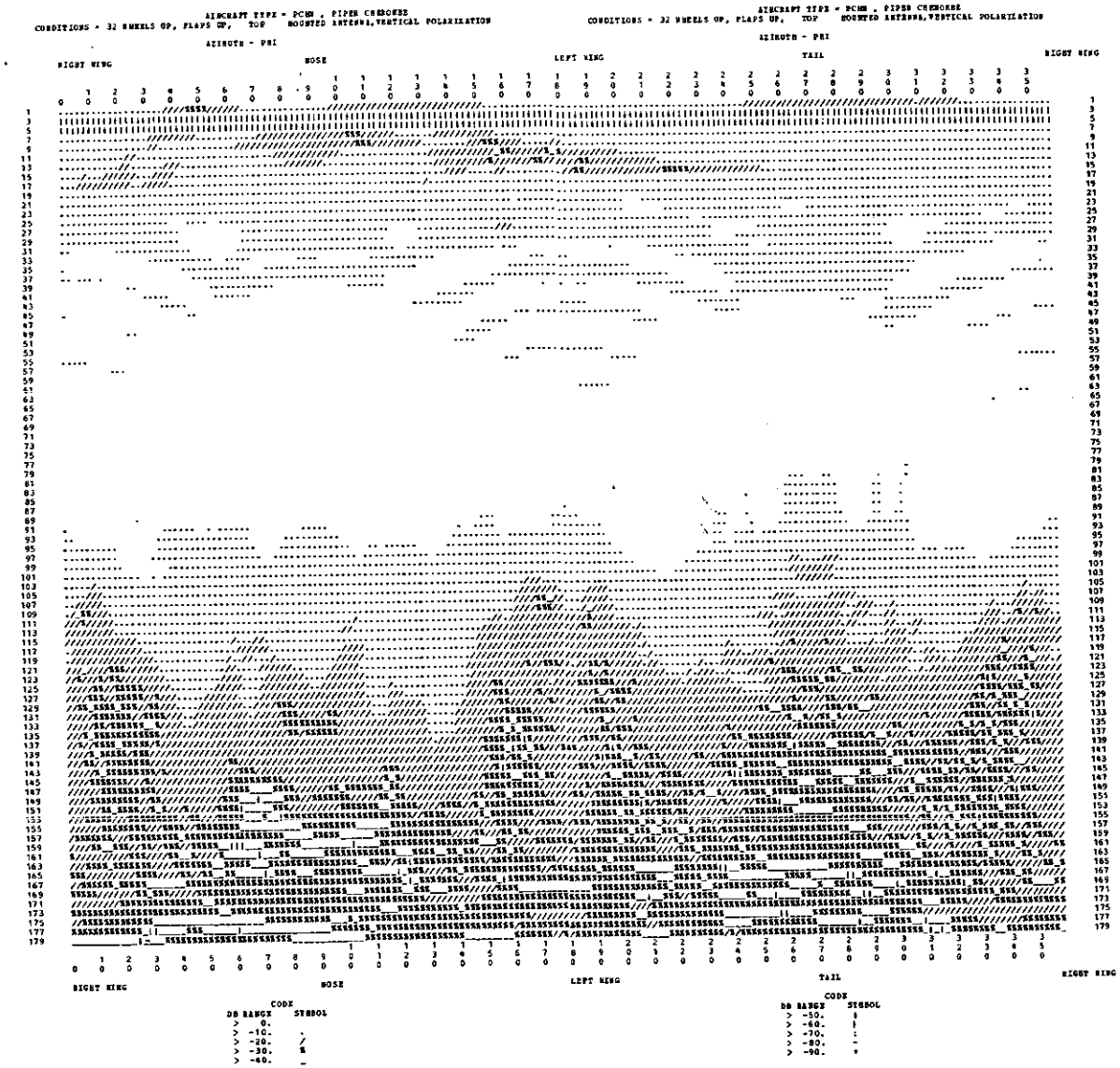

Fig. 3-5. Piper Cherokee Arrow; antenna position 2 (T); wheels up, flaps up.

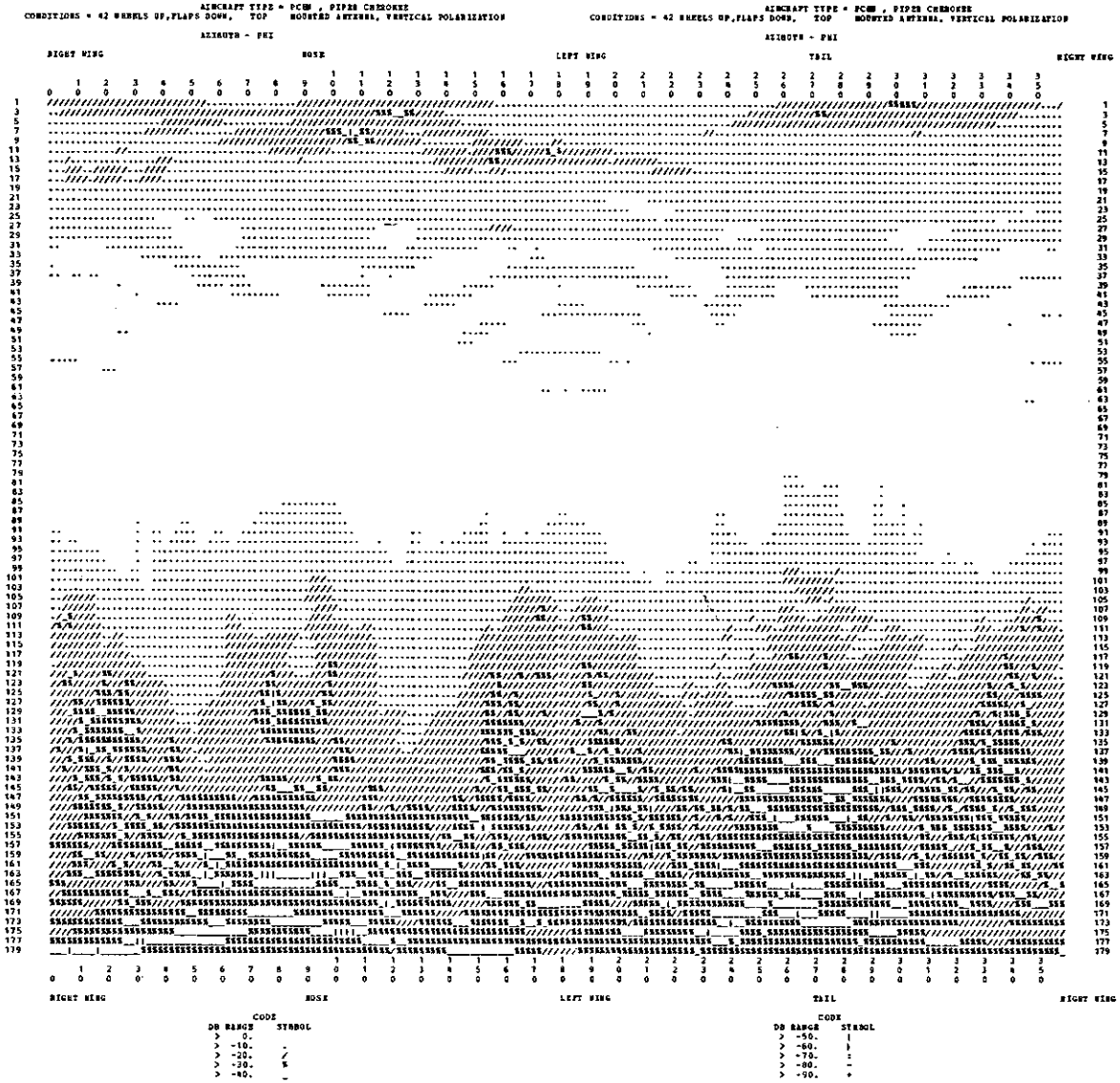

Fig. 3-6. Piper Cherokee Arrow; antenna position 2 (T); wheels up, flaps down.

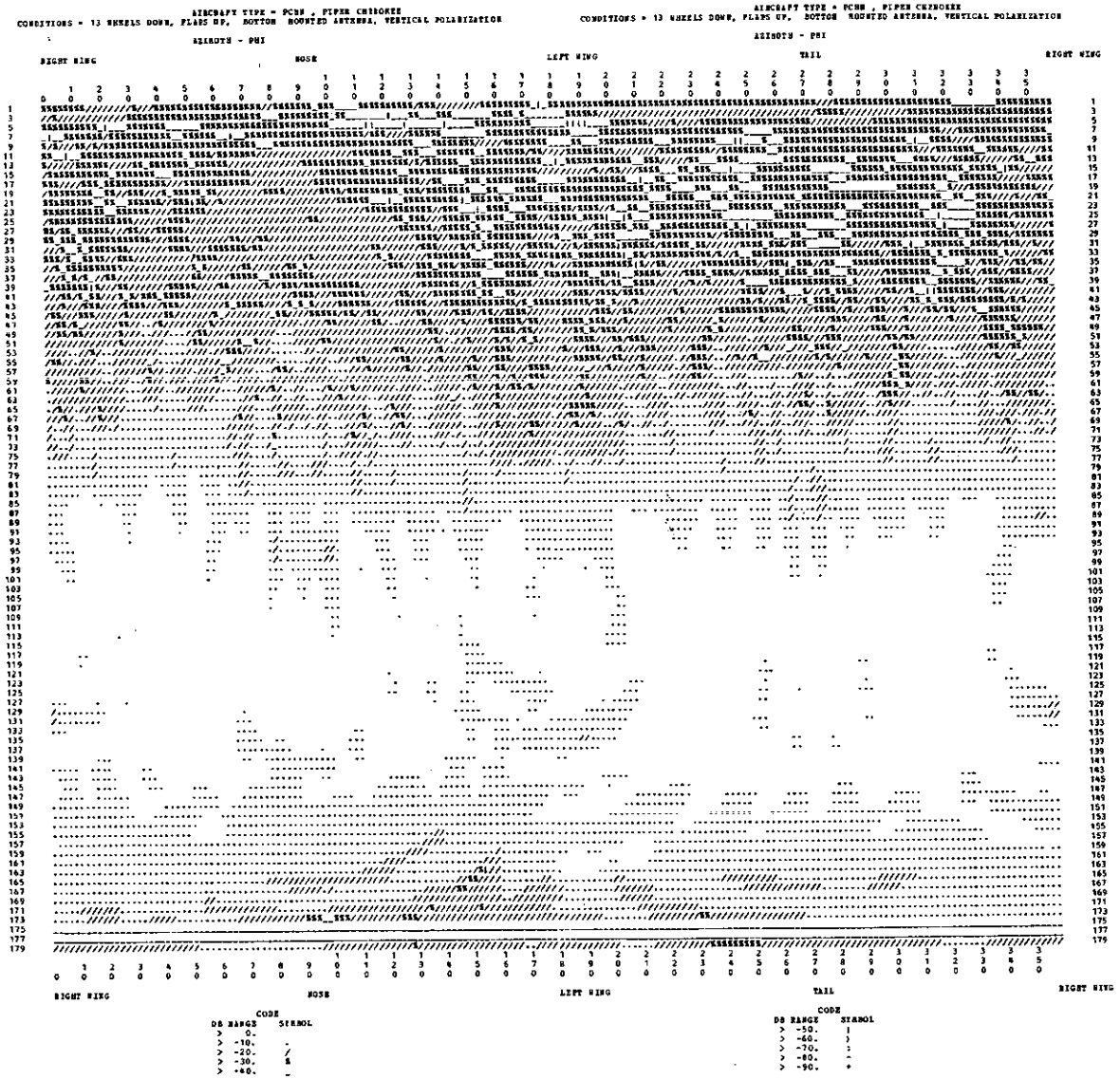

Fig. 3-7. Piper Cherokee Arrow; antenna position 3 (B); wheels down, flaps up.

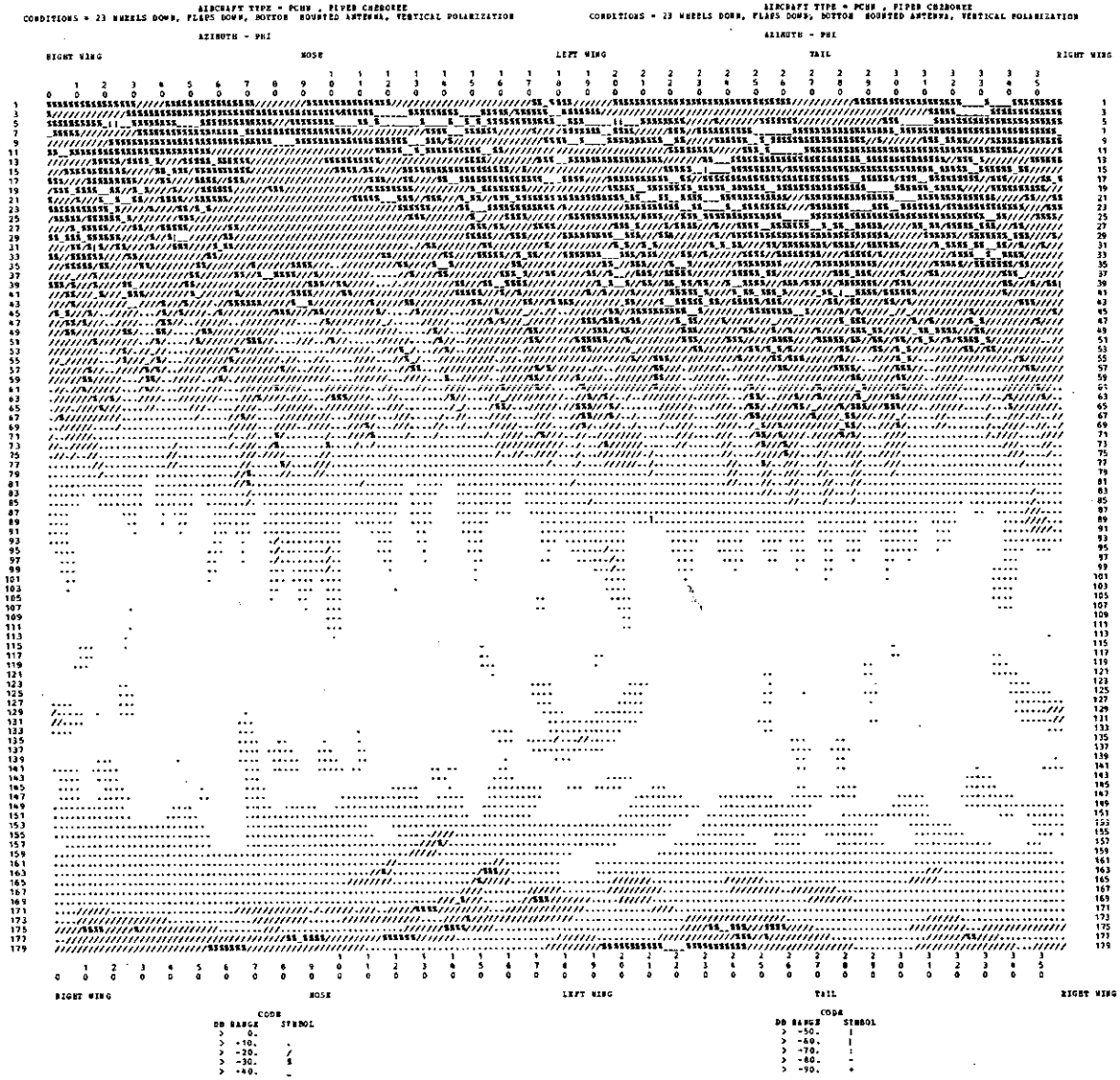

Fig. 3-8. Piper Cherokee Arrow; antenna position 3 (B); wheels down, flaps down.

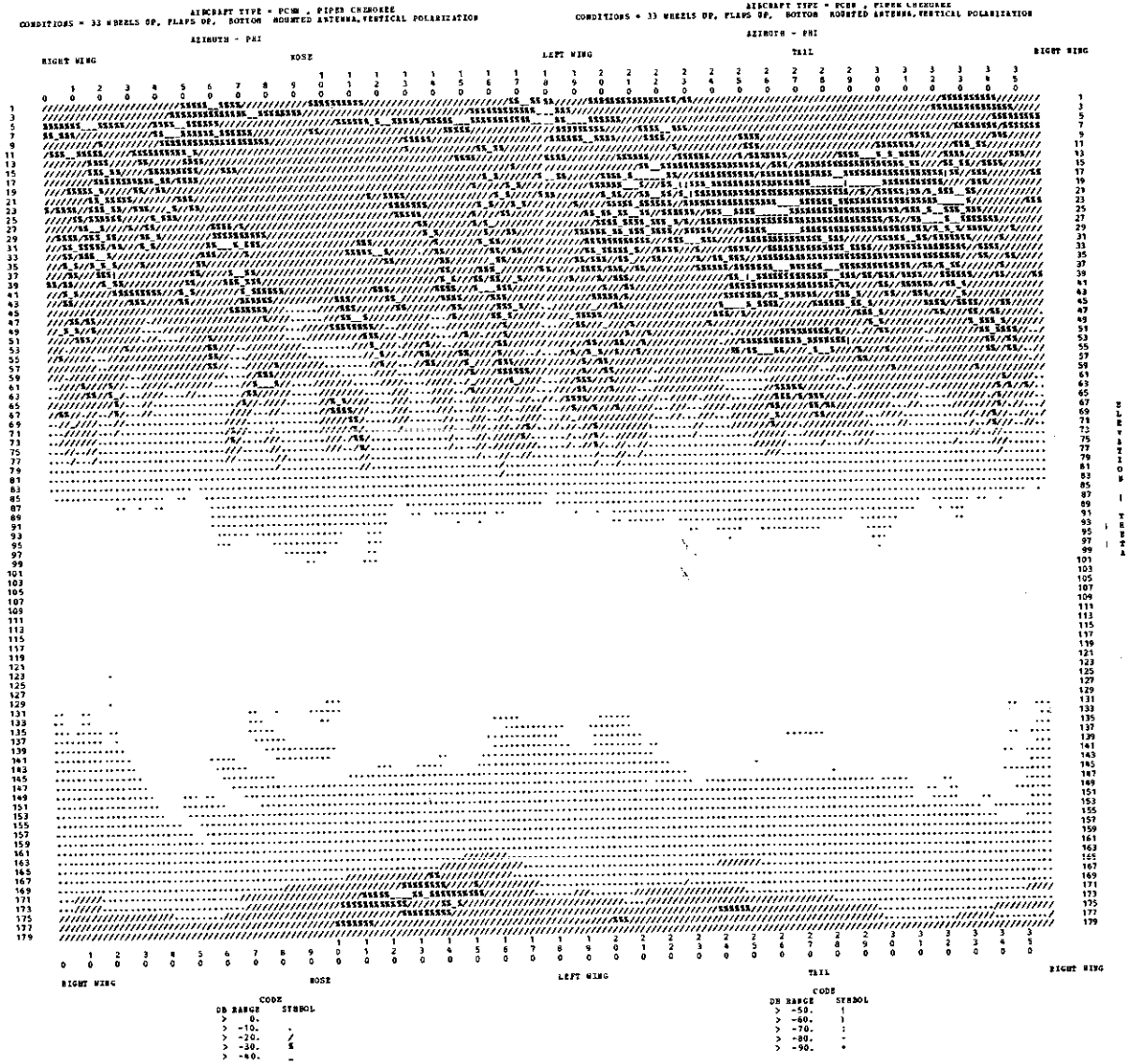

Fig. 3-9. Piper Cherokee Arrow; antenna position 3 (B); wheels up, flaps up.

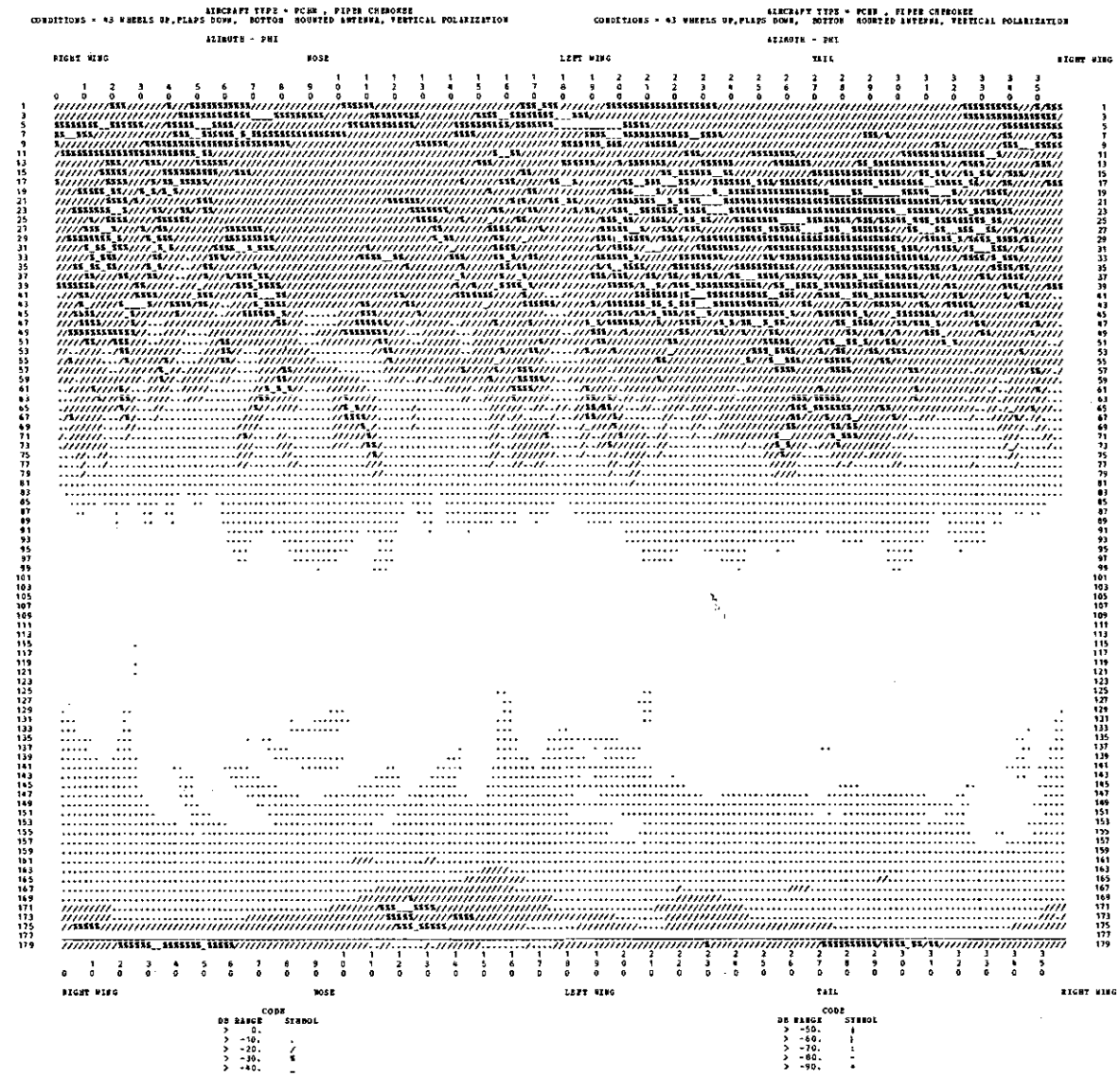

Fig. 3-10. Piper Cherokee Arrow; antenna position 3 (B); wheels up, flaps down.

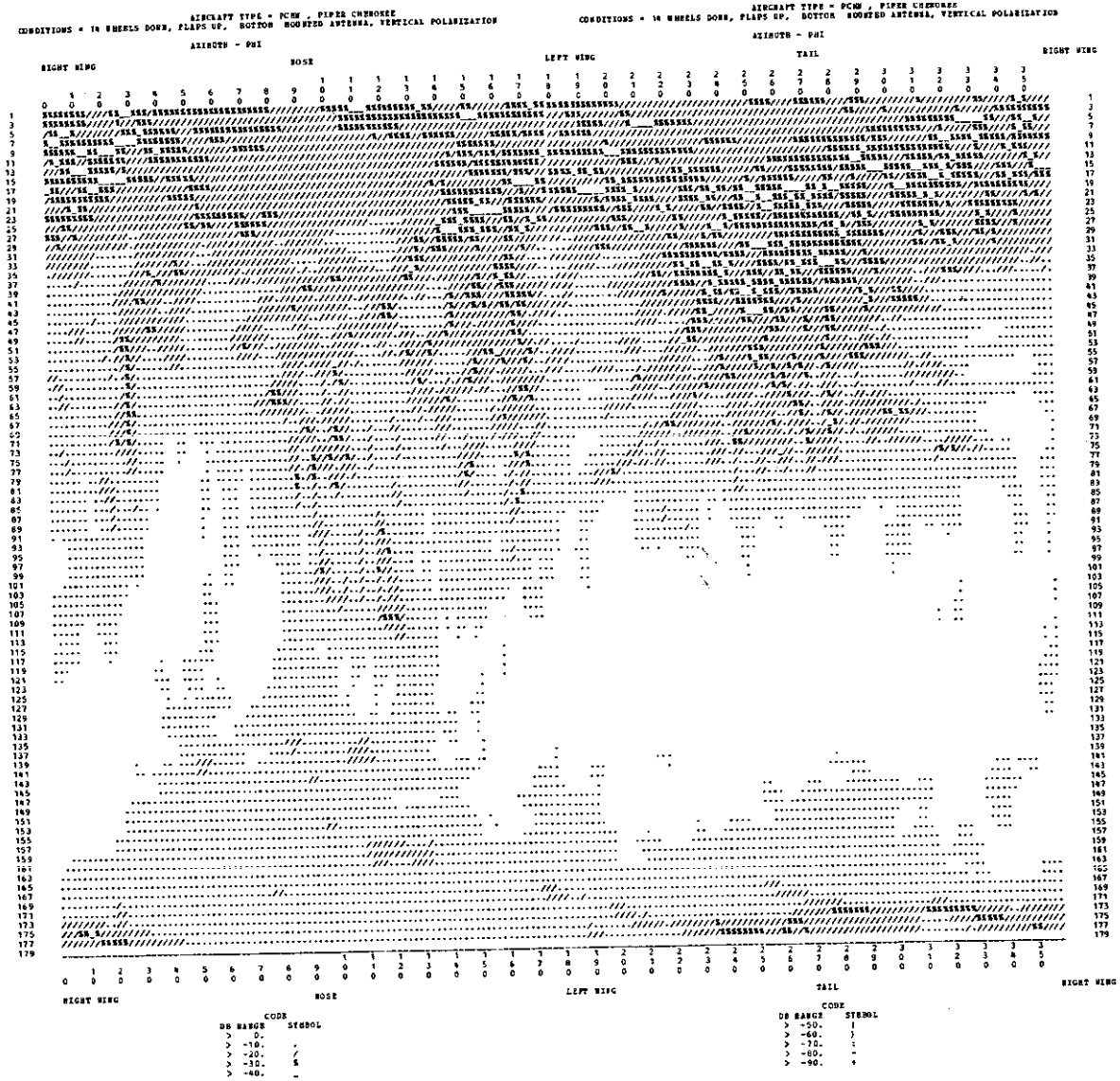

Fig. 3-11. Piper Cherokee Arrow; antenna position 4 (B); wheels down, flaps up.

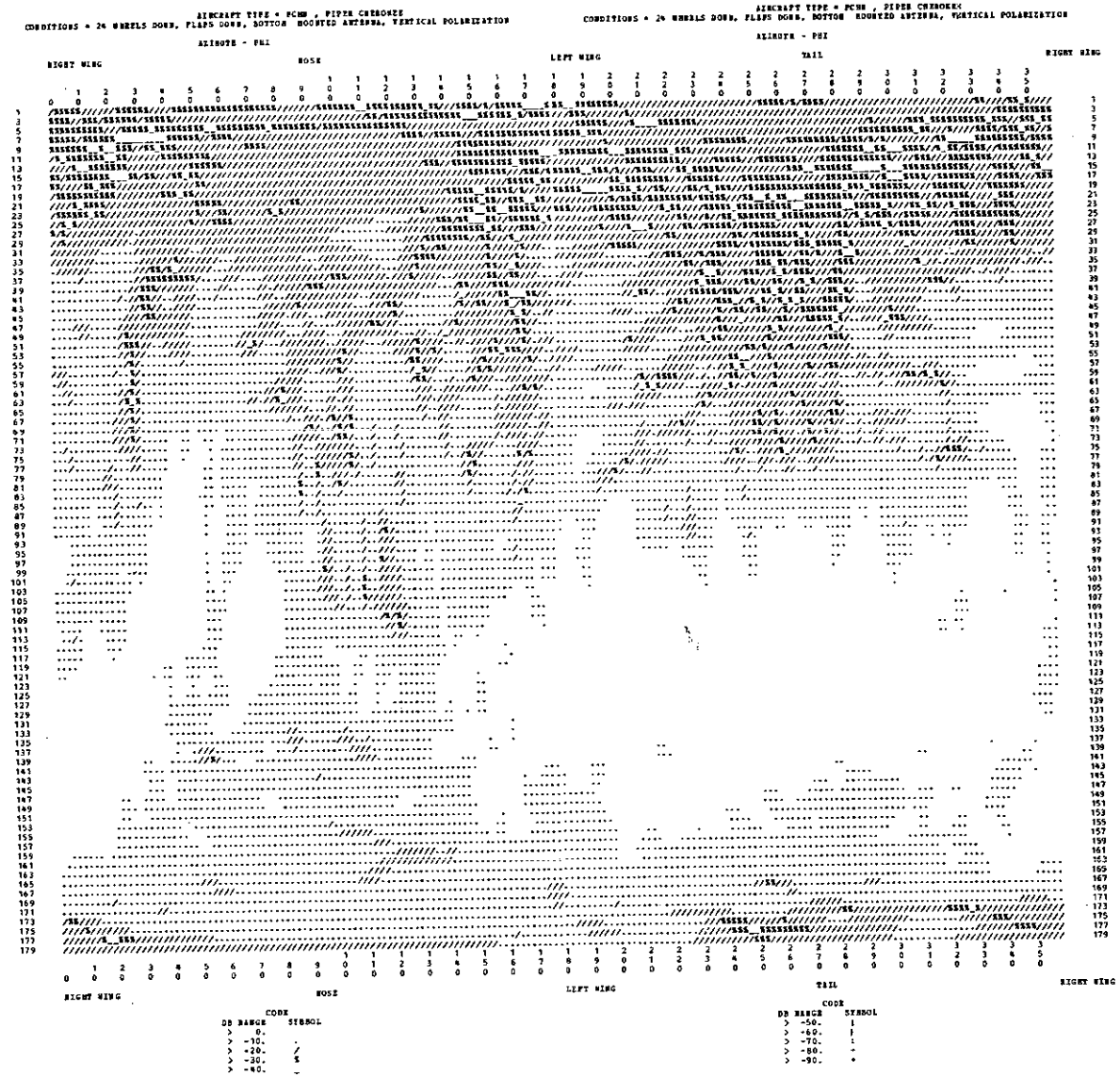

Fig. 3-12. Piper Cherokee Arrow; antenna position 4 (B); wheels down, flaps down.

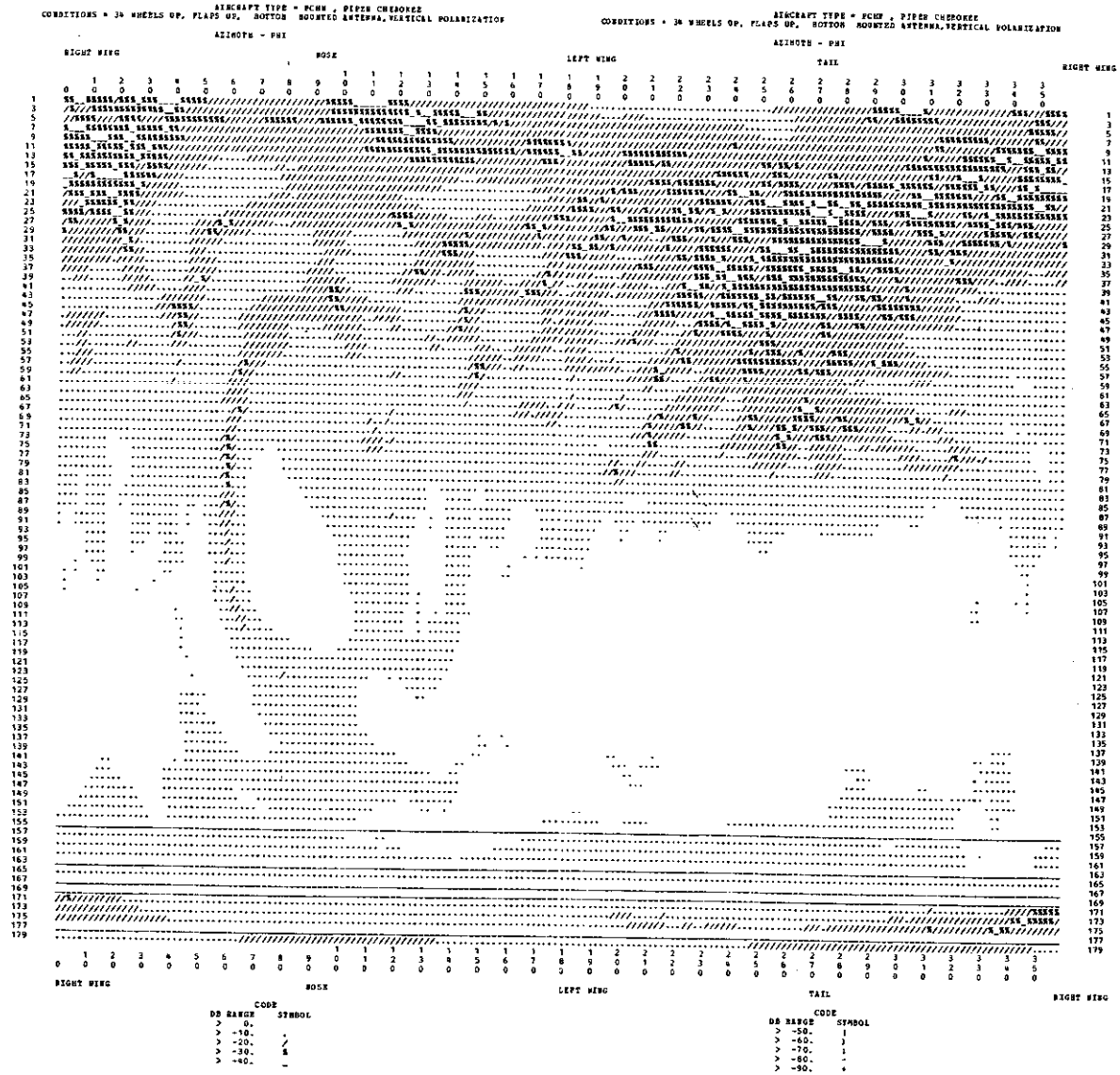

Fig. 3-13. Piper Cherokee Arrow; antenna position 4 (B); wheels up, flaps up.

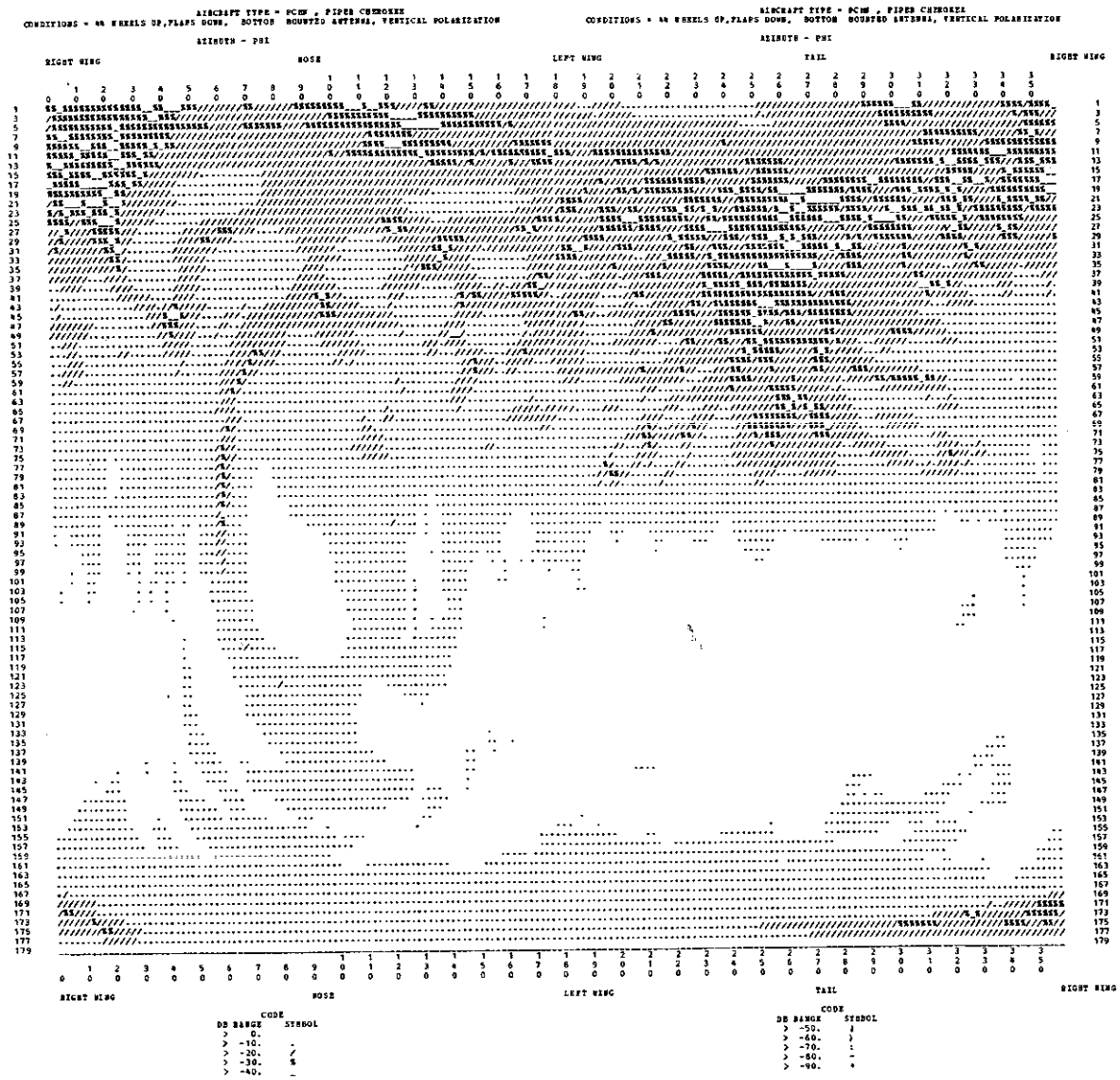

Fig. 3-14. Piper Cherokee Arrow; antenna position 4 (B); wheels up, flaps down.

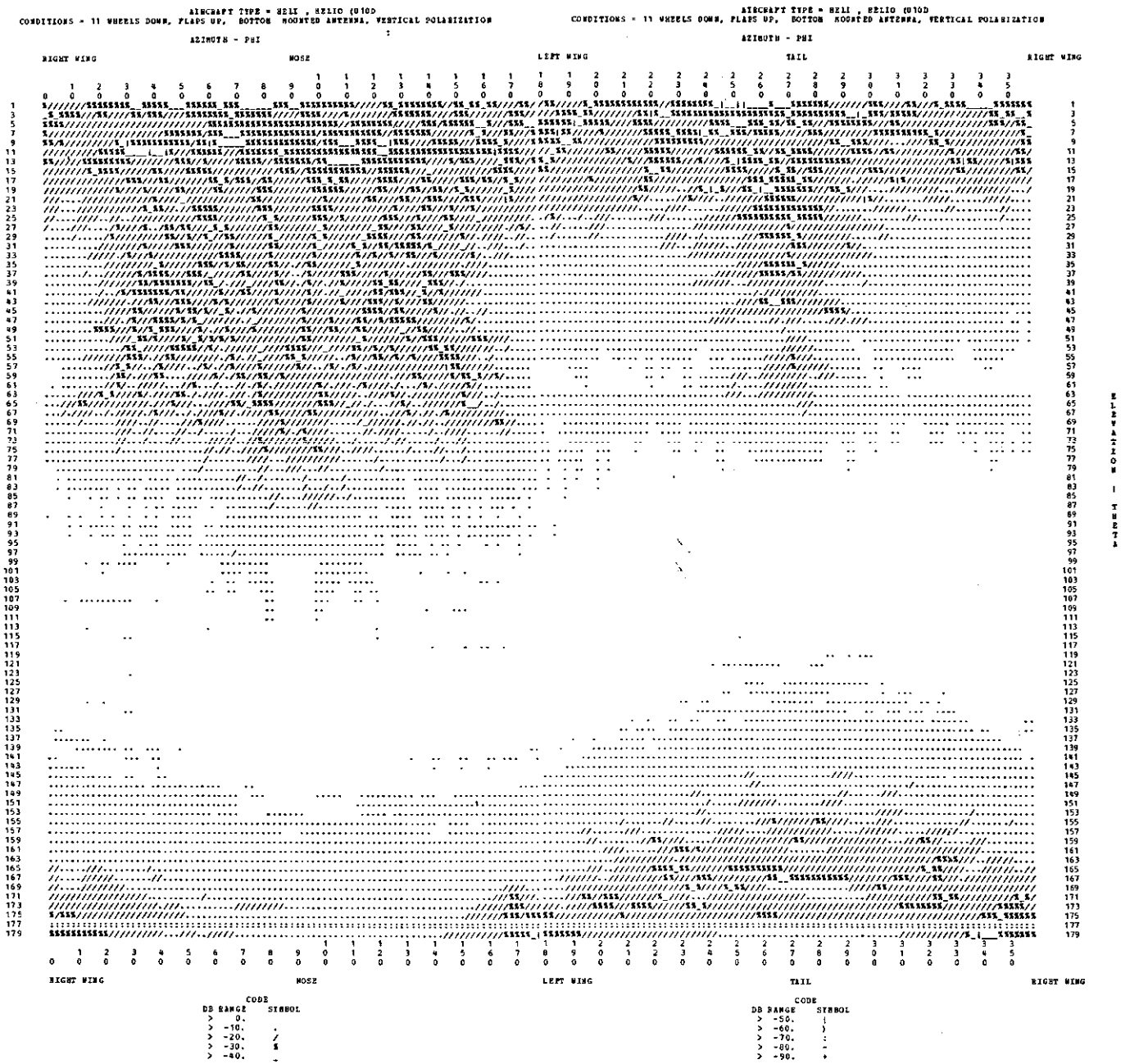

Fig. 4-1. Helio U10D; antenna position 1 (B); wheels down, flaps up.

C45-1211

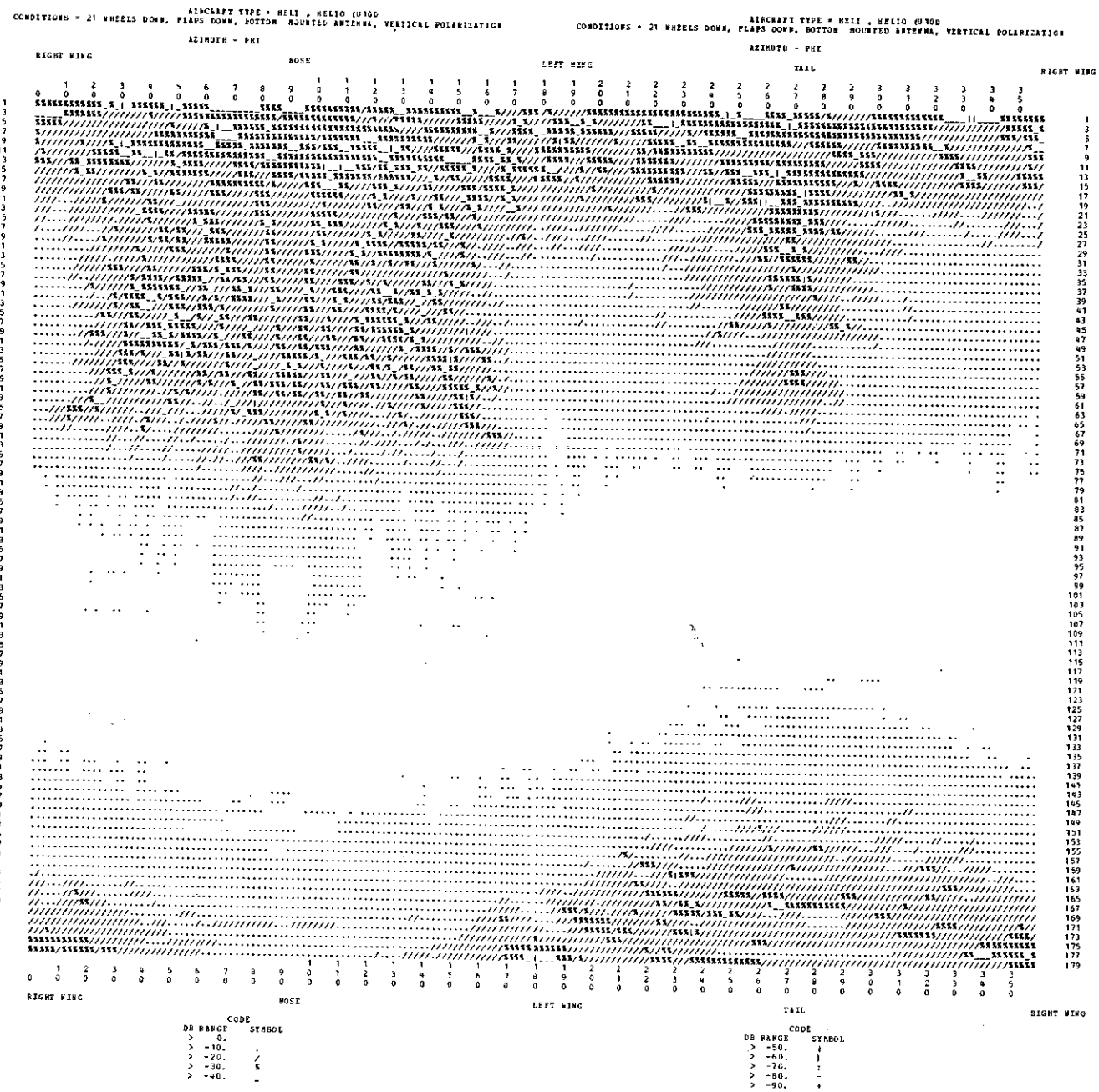

Fig. 4-2. Helio U10D; antenna position 1 (B); wheels down, flaps down.

C45-1212

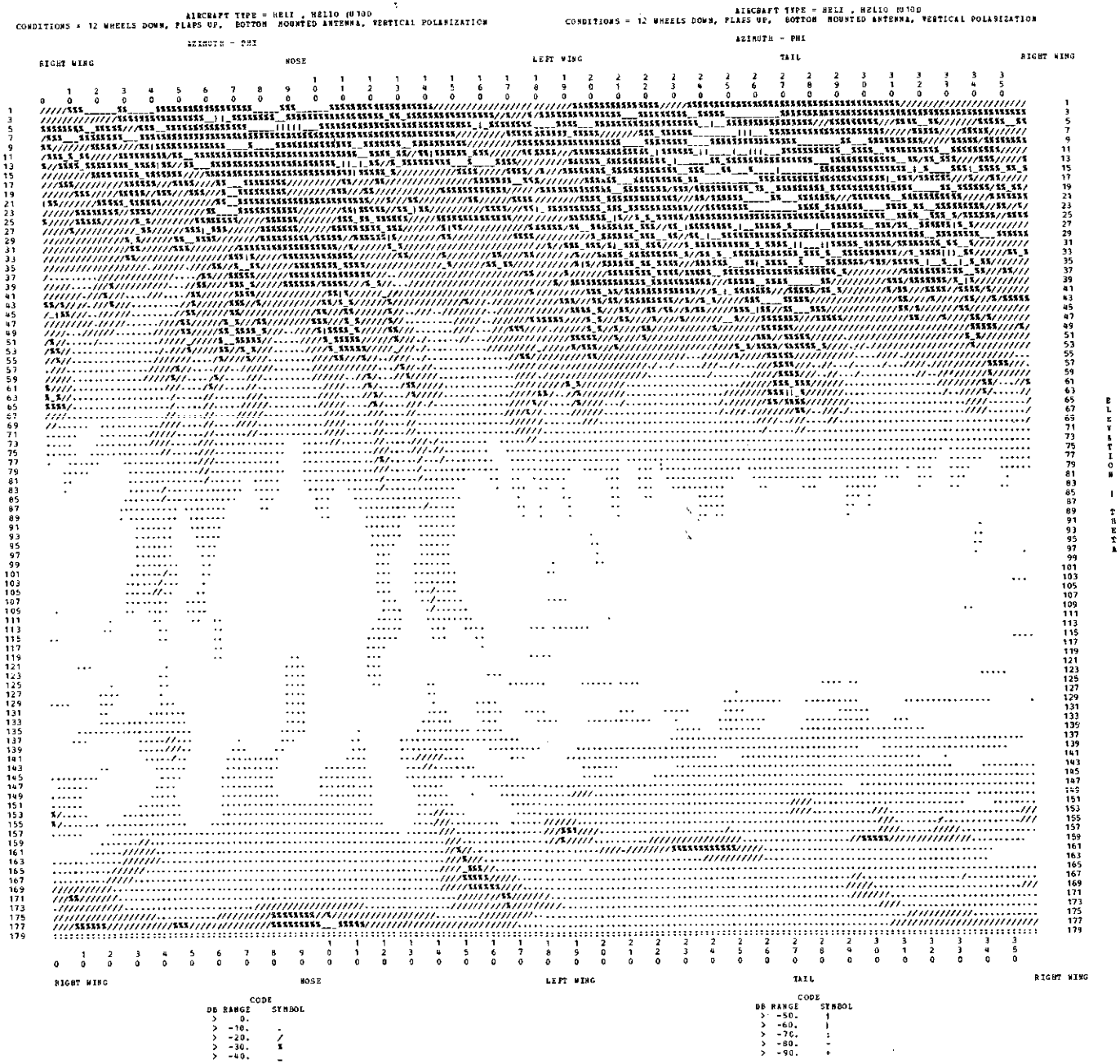

Fig. 4-3. Helio U10D; antenna position 2 (B); wheels down, flaps up.

C45-1213

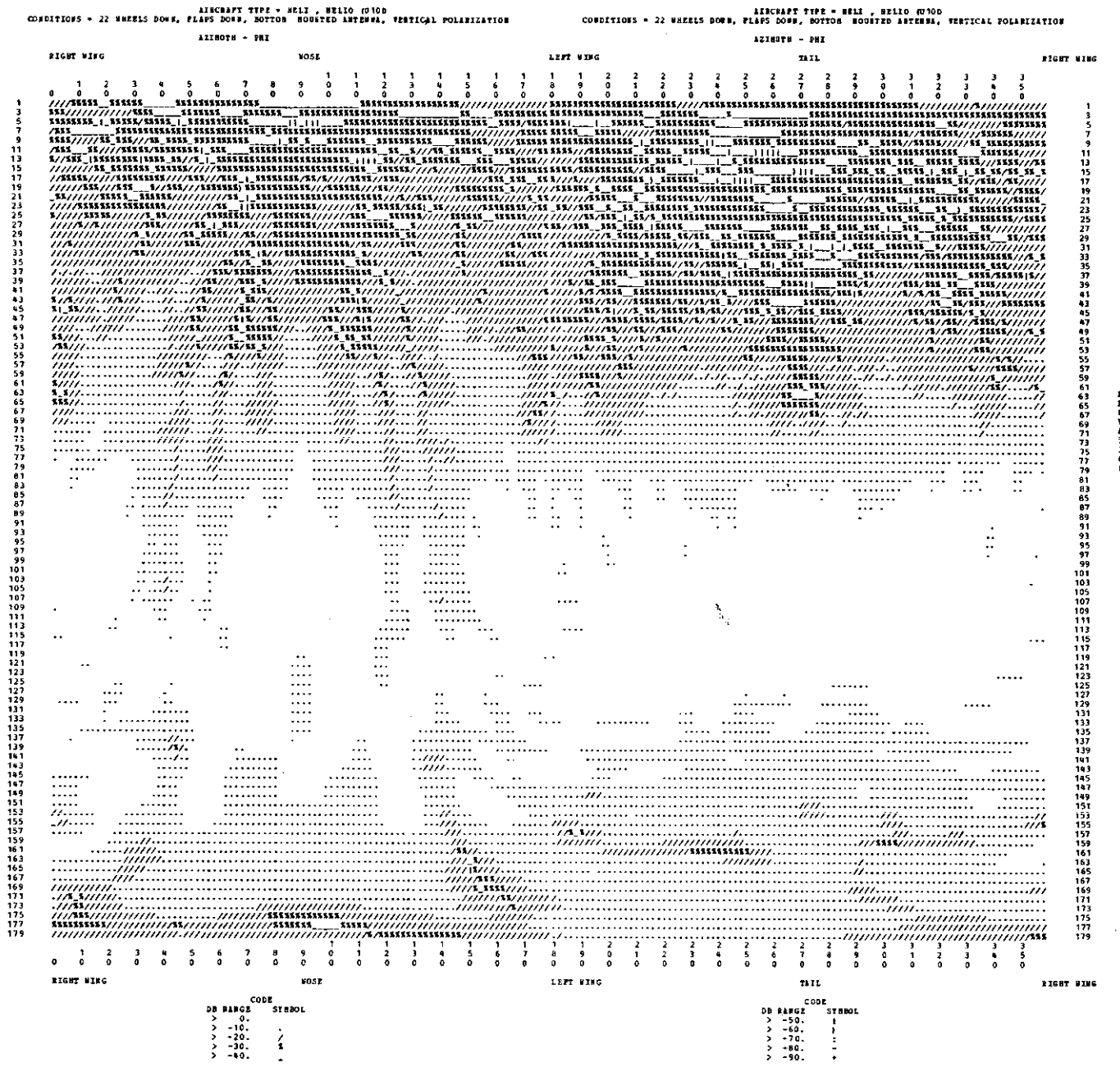

Fig. 4-4. Helio U10D; antenna position 2 (B); wheels down, flaps down.

C45-1214

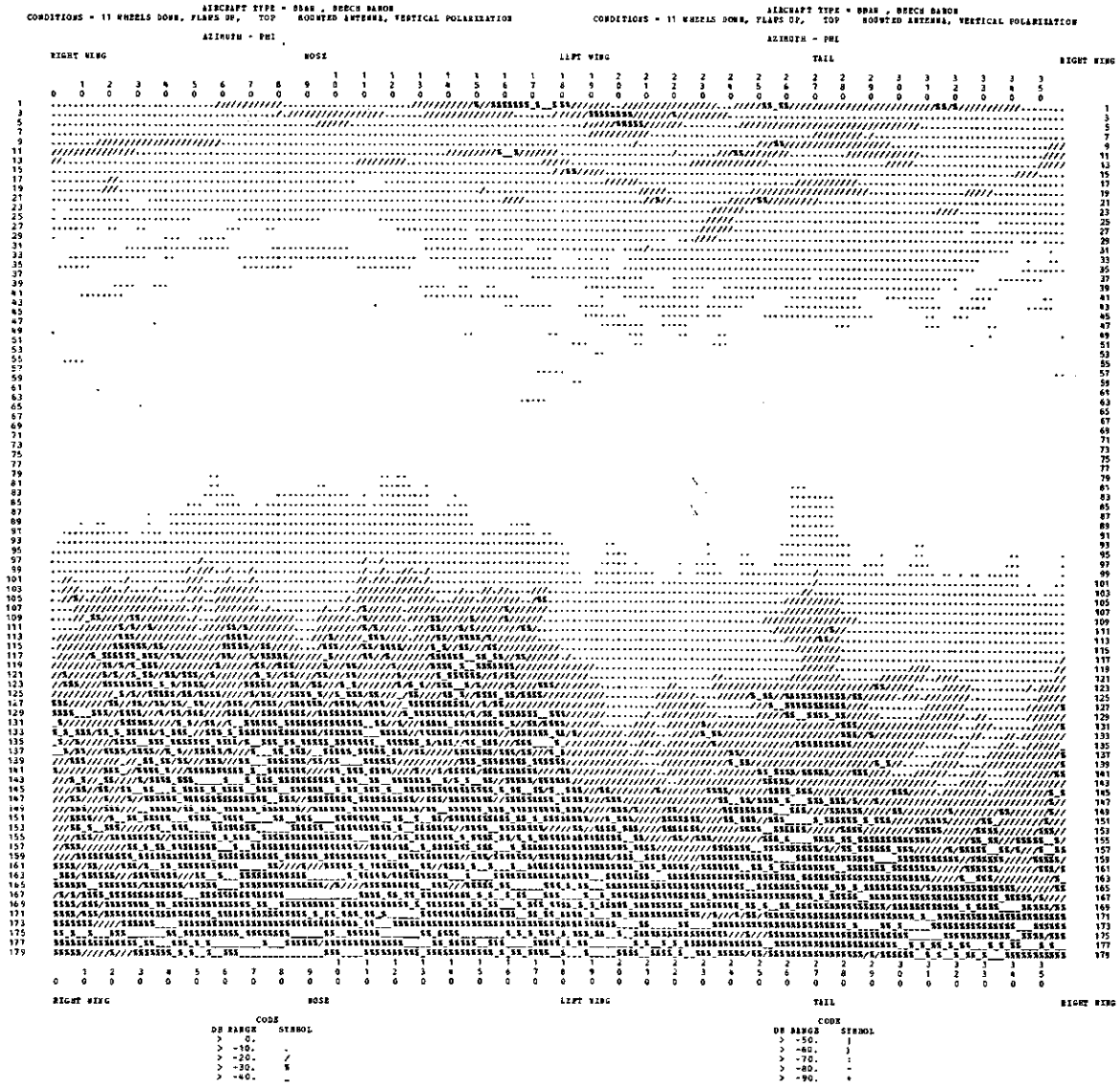

Fig. 5-1. Beechcraft Baron; antenna position 1 (T); wheels down, flaps up.

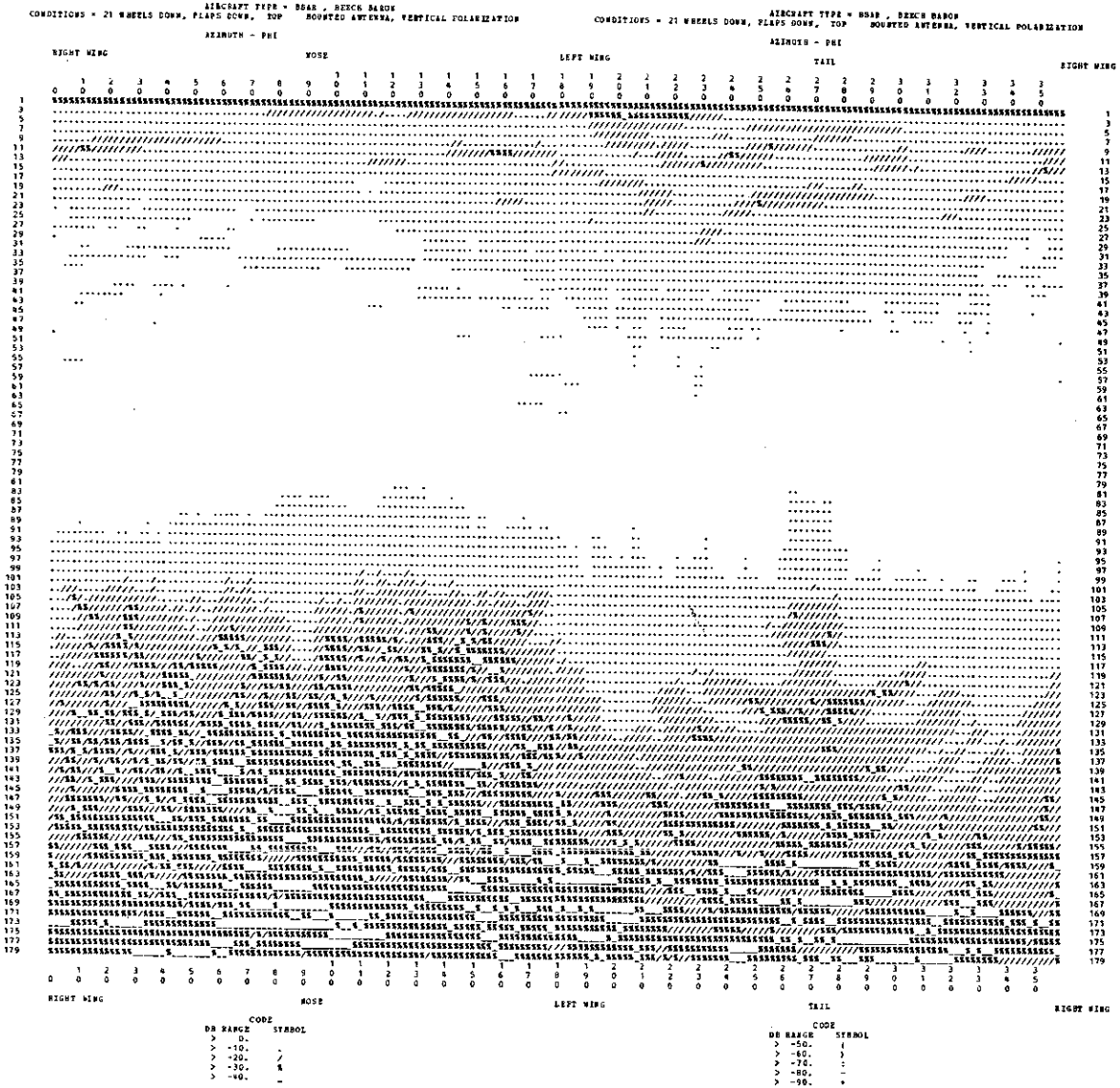

Fig. 5-2. Beechcraft Baron; antenna position 1 (T); wheels down, flaps down.

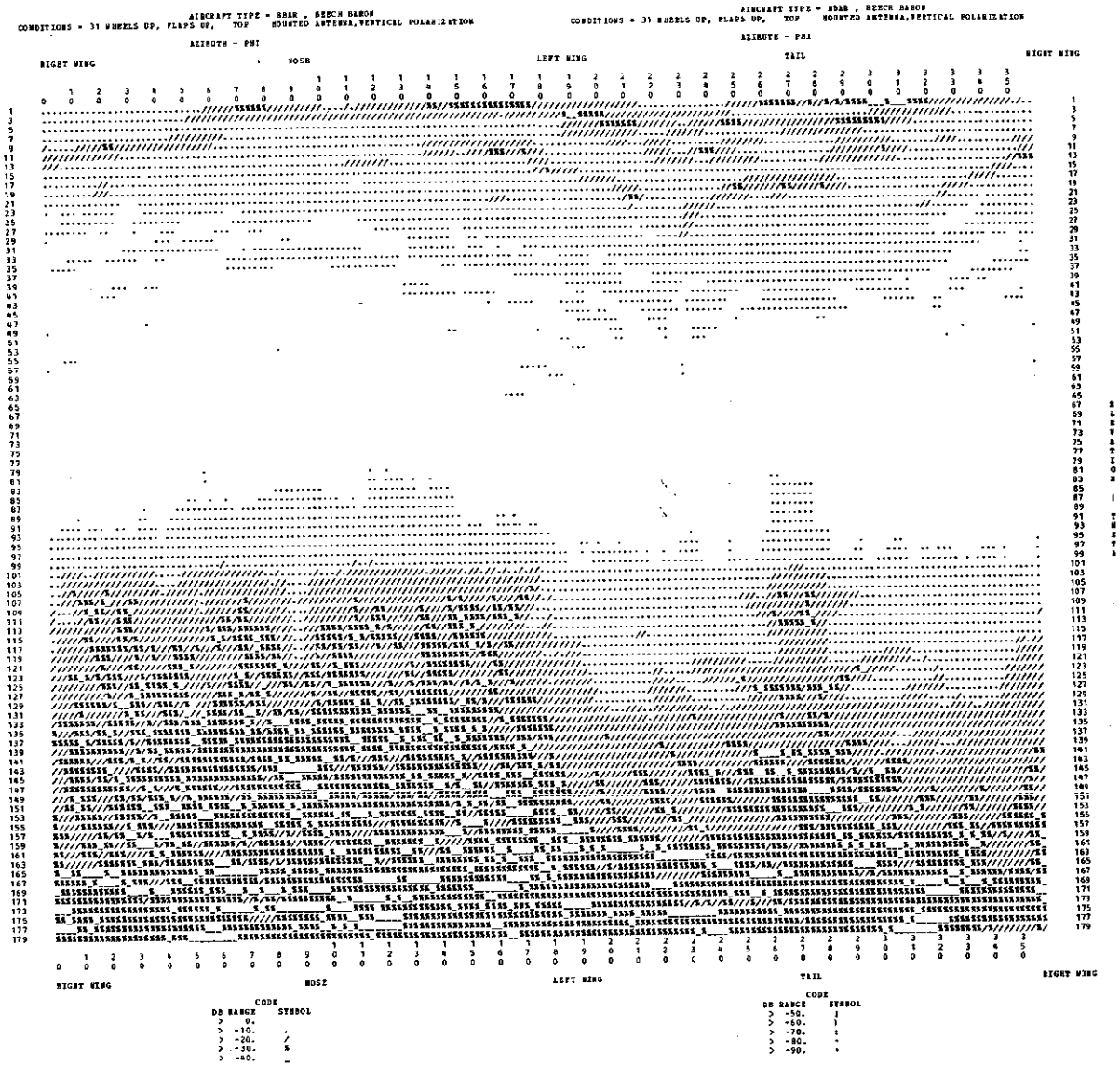

Fig. 5-3. Beechcraft Baron; antenna position 1 (T); wheels down, flaps up.

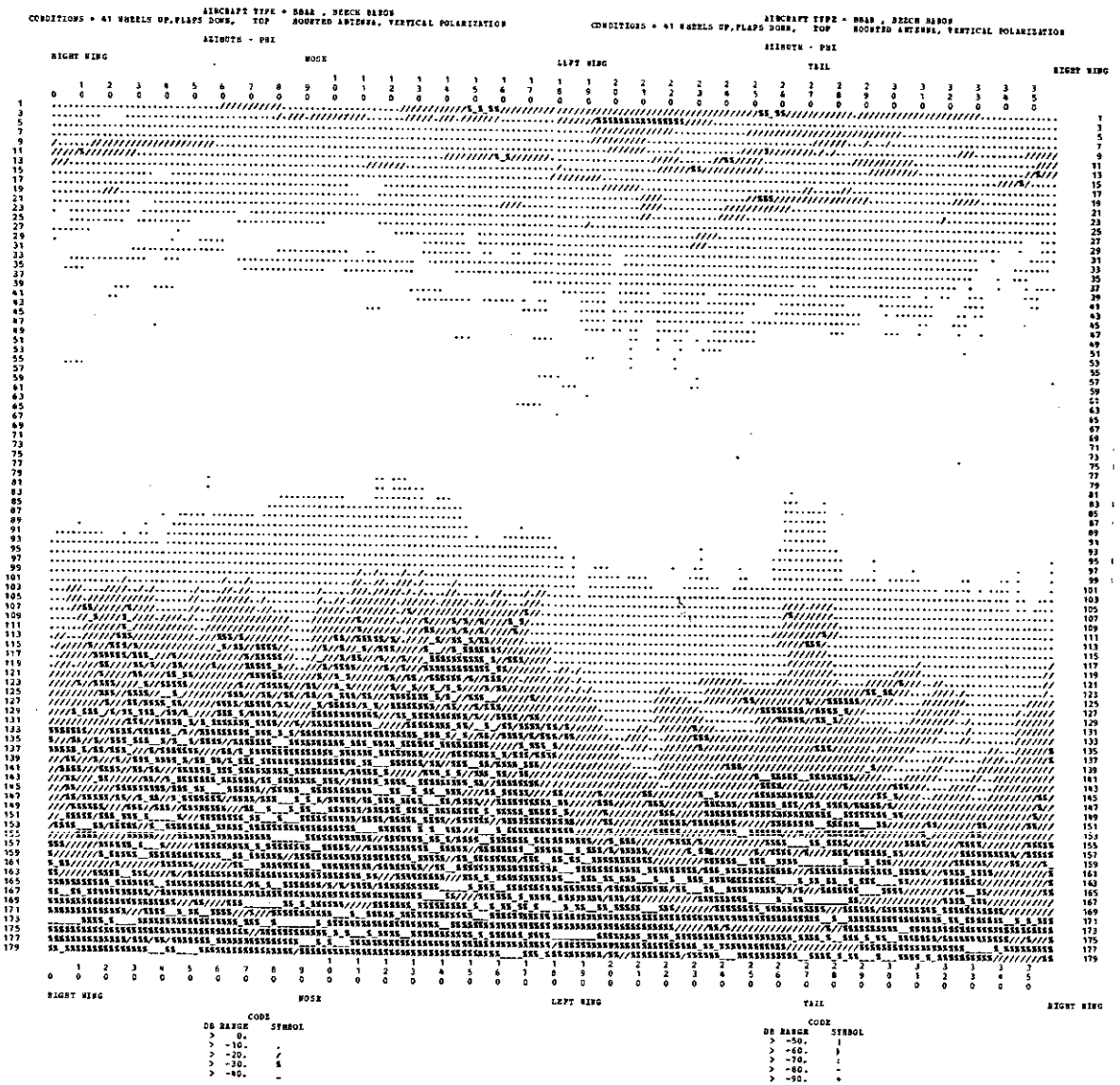

Fig. 5-4. Beechcraft Baron; antenna position 1 (T); wheels up, flaps down.

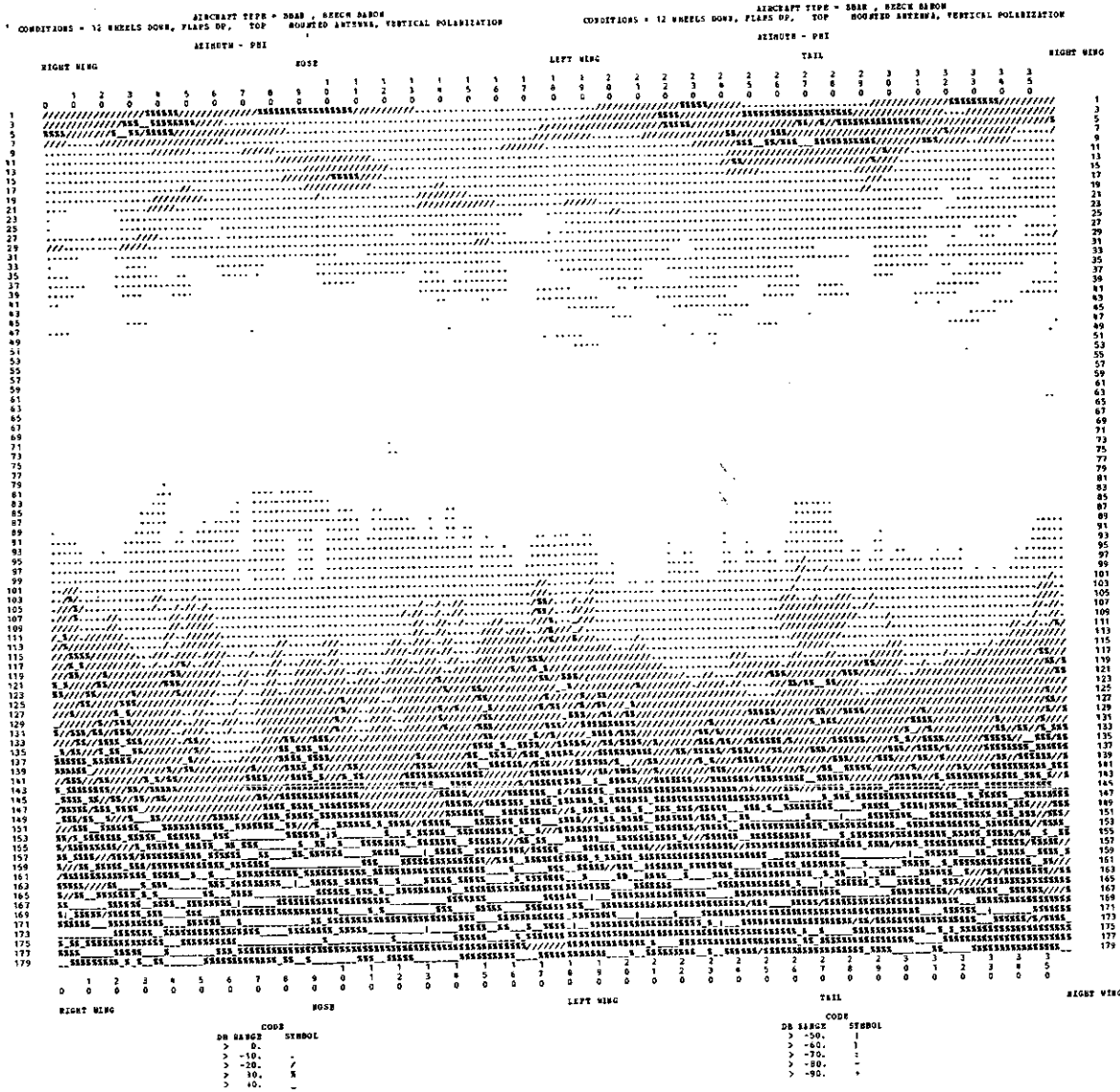

Fig. 5-5. Beechcraft Baron; antenna position 2 (T); wheels down, flaps up.

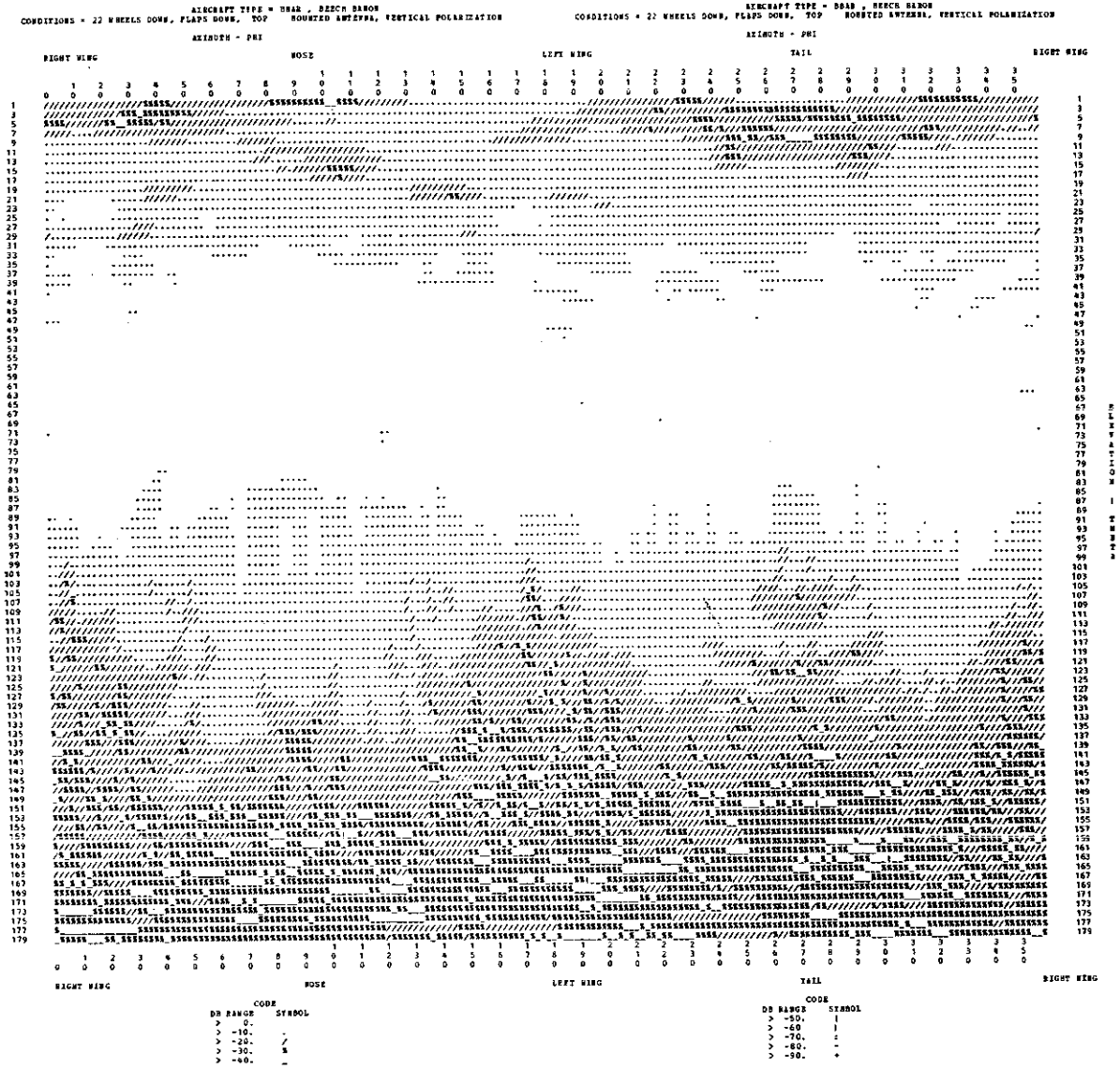

Fig. 5-6. Beechcraft Baron; antenna position 2 (T); wheels down, flaps down.

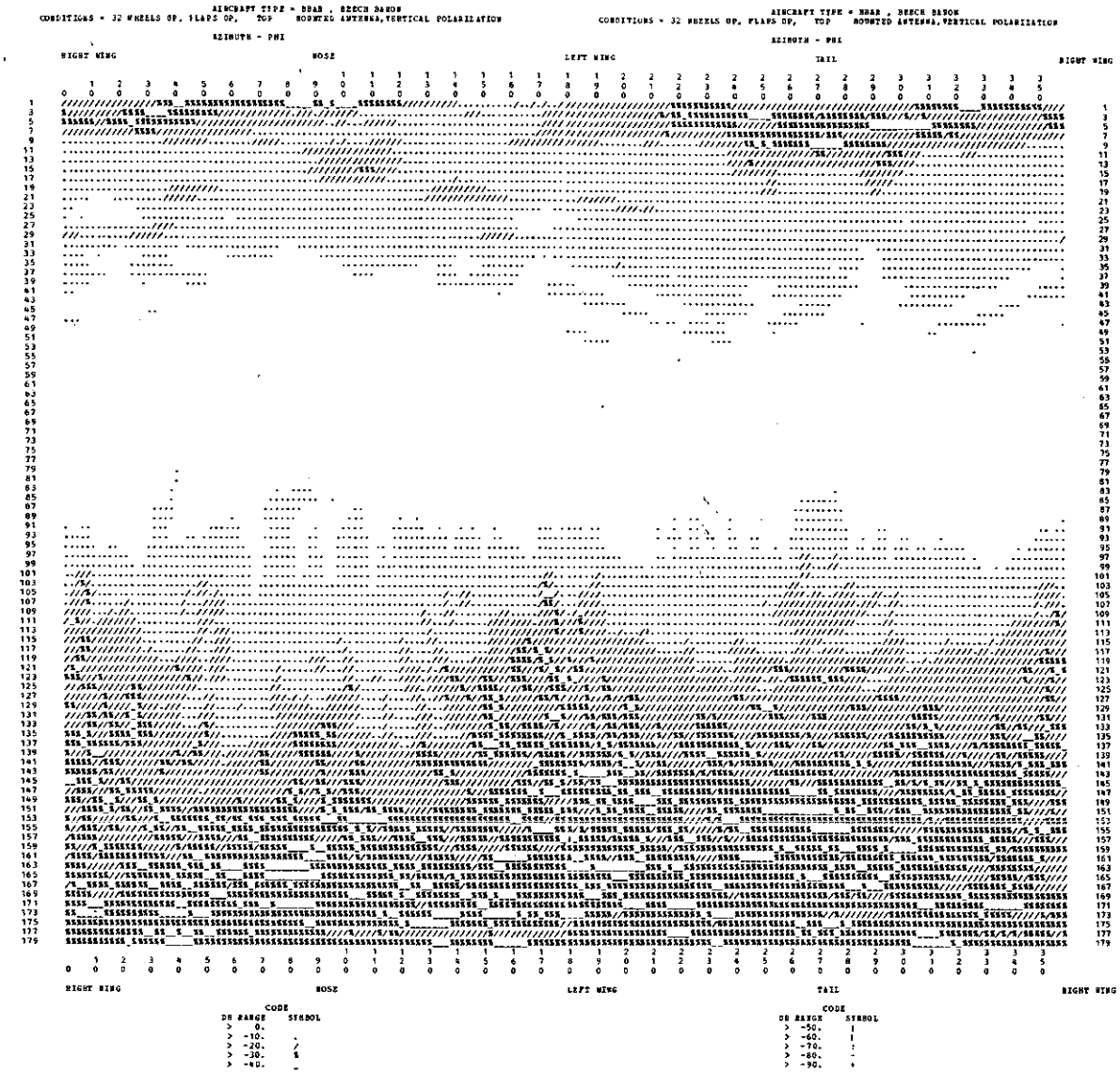

Fig. 5-7. Beechcraft Baron; antenna position 2 (T); wheels up, flaps up.

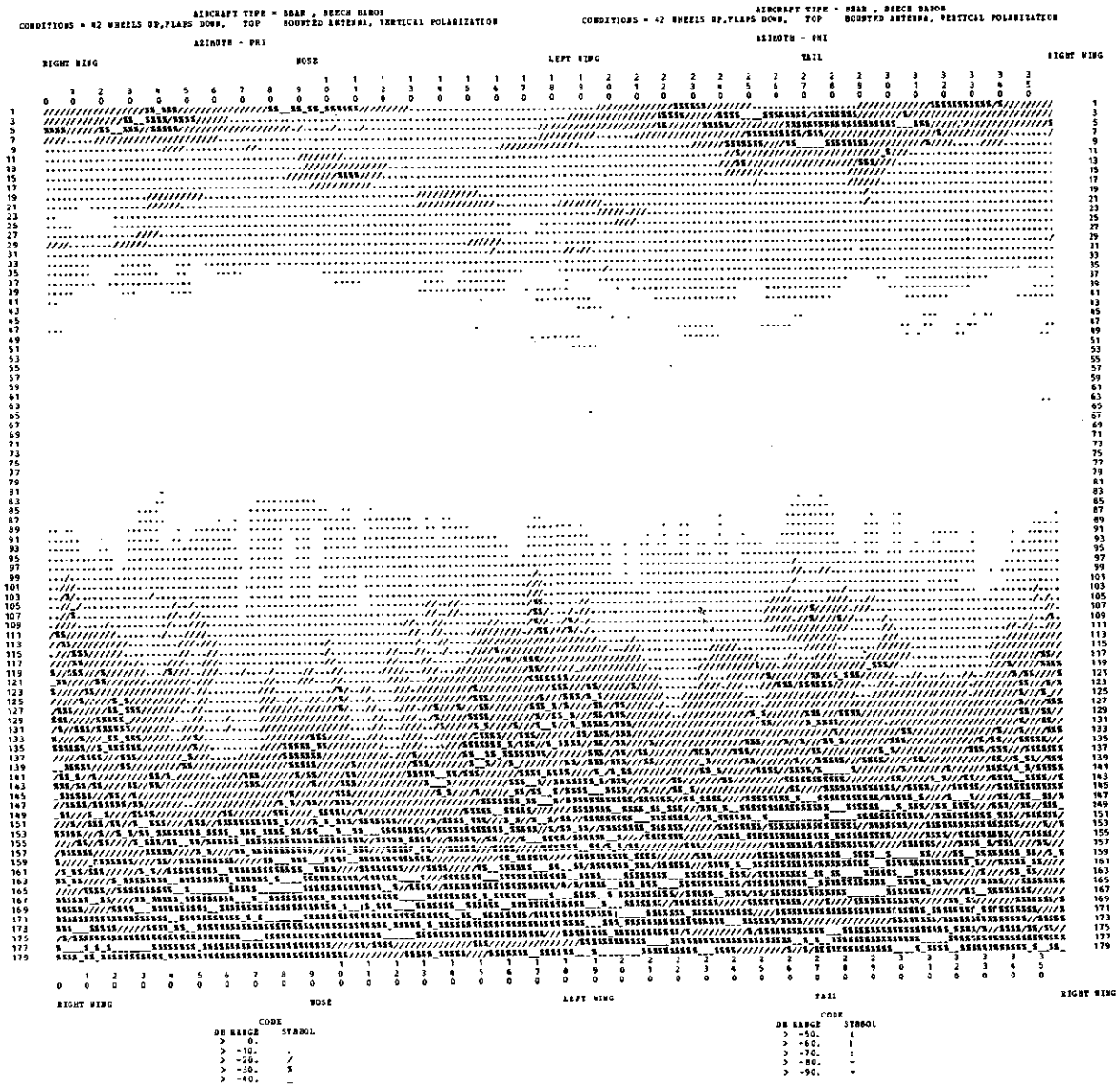

Fig. 5-8. Beechcraft Baron; antenna position 2 (T); wheels up, flaps down.

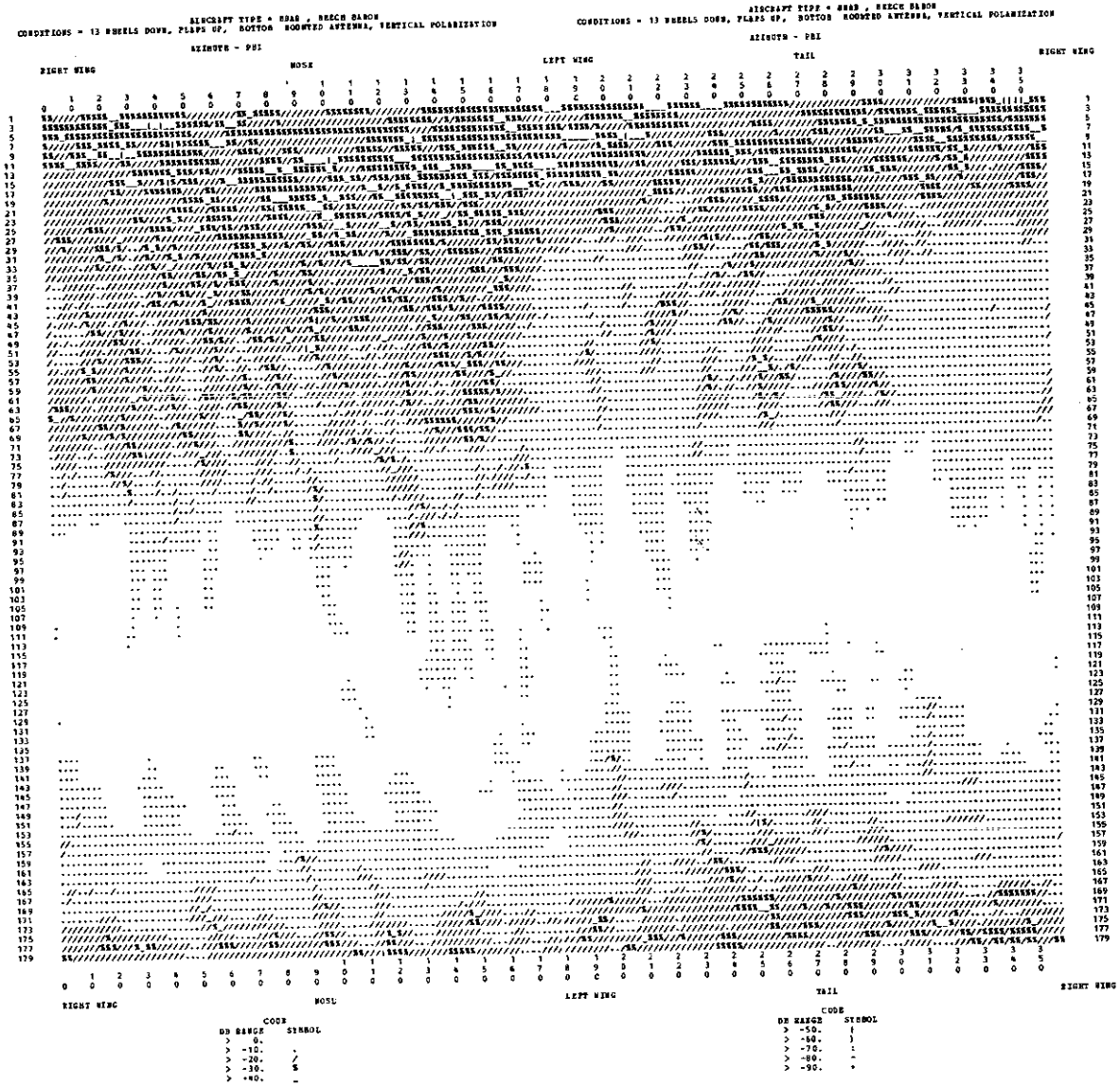

Fig. 5-9. Beechcraft Baron; antenna position 3 (B); wheels down, flaps up.

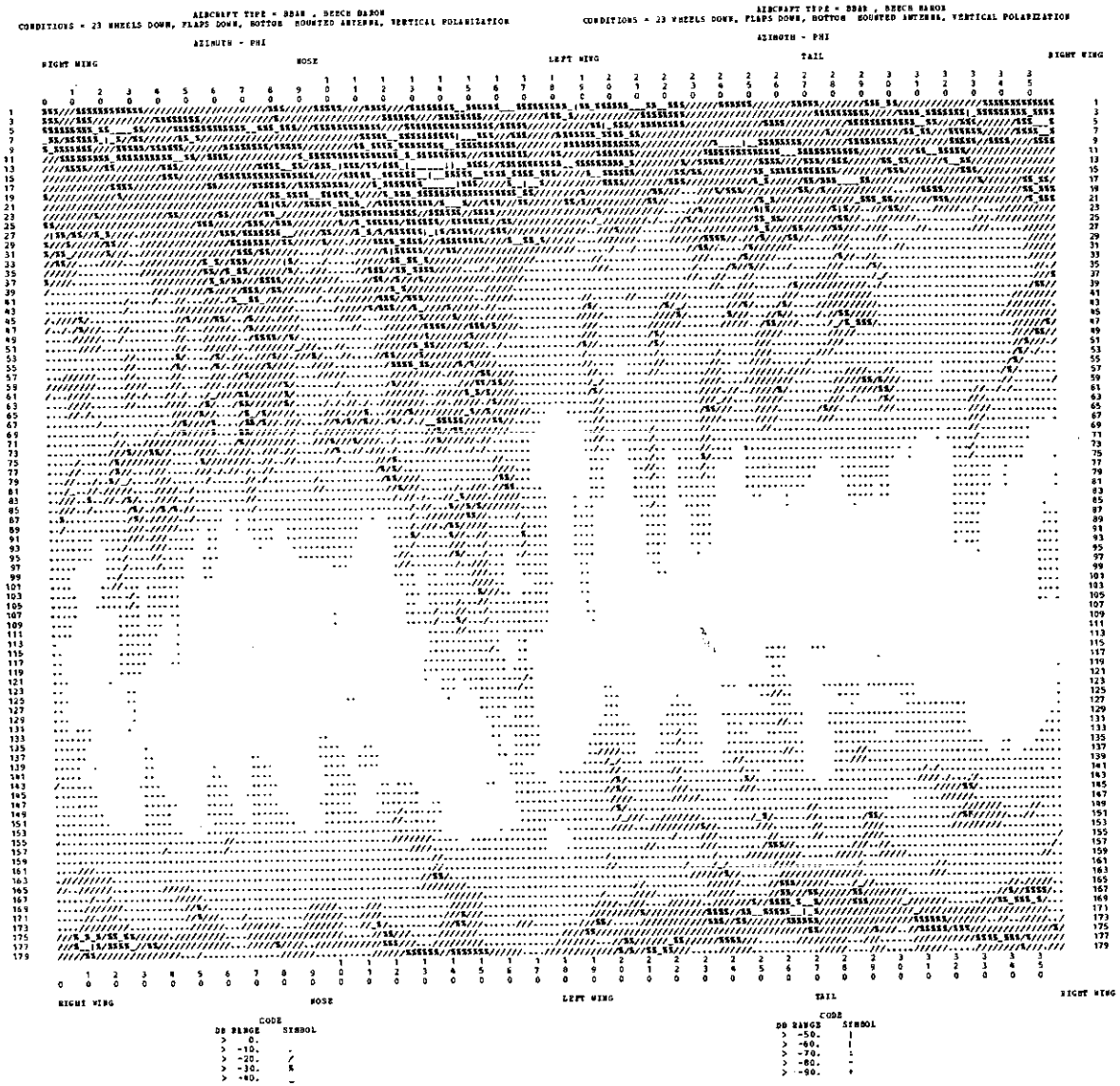

Fig. 5-10. Beechcraft Baron; antenna position 3 (B); wheels down, flaps down.

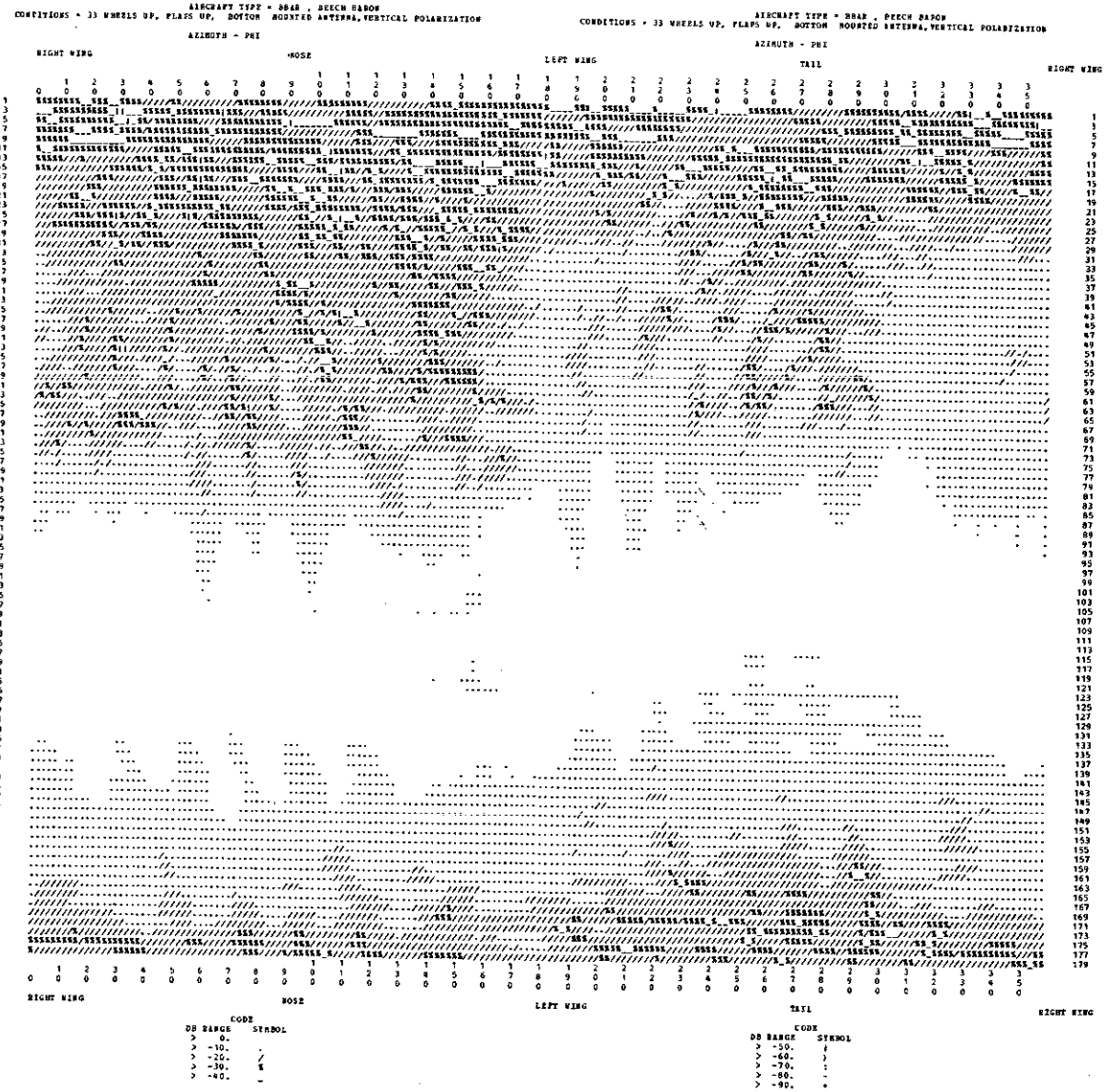

Fig. 5-11. Beechcraft Baron; antenna position 3 (B); wheels up, flaps up.

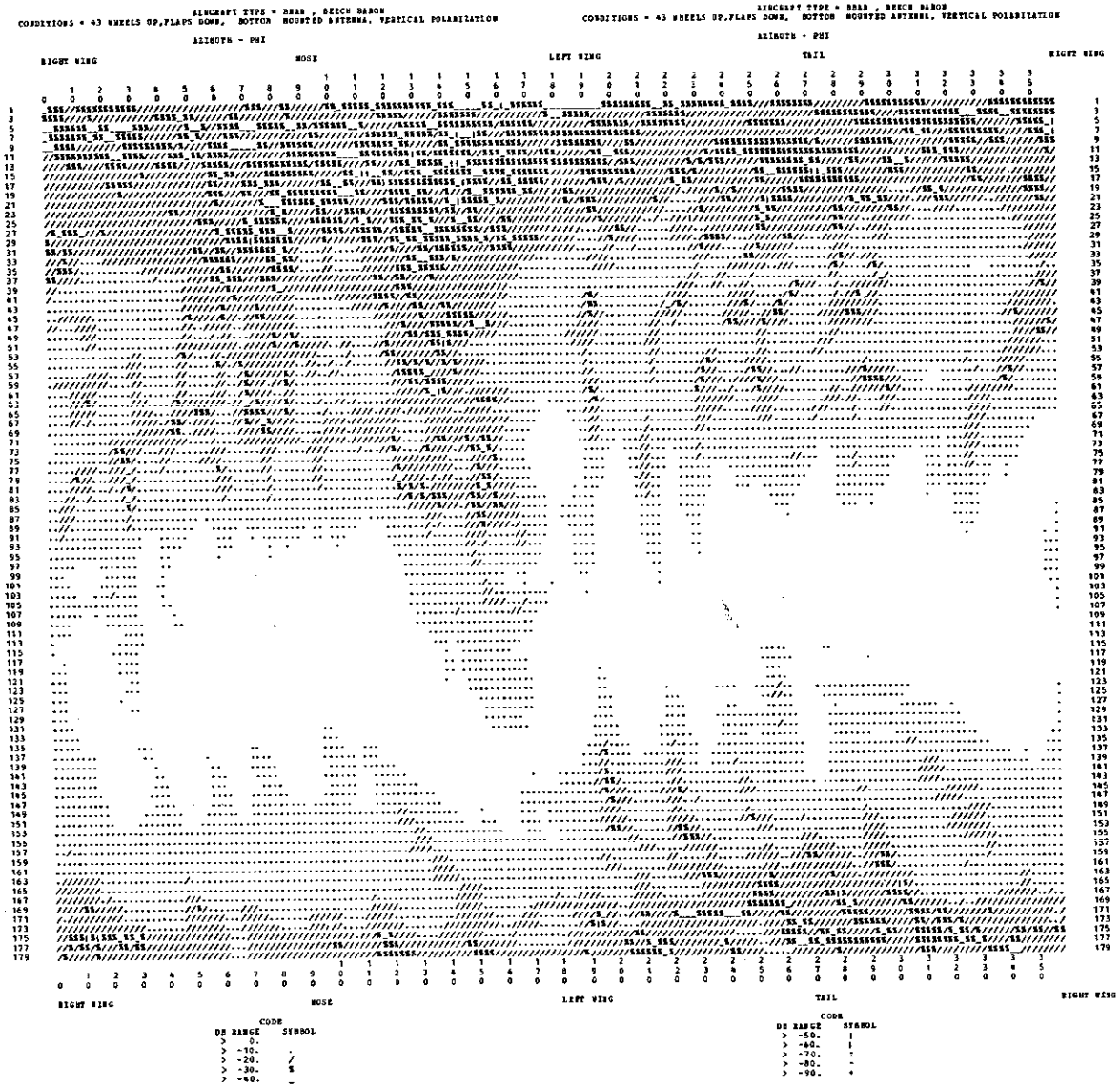

Fig. 5-12. Beechcraft Baron; antenna position 3 (B); wheels up, flaps down.

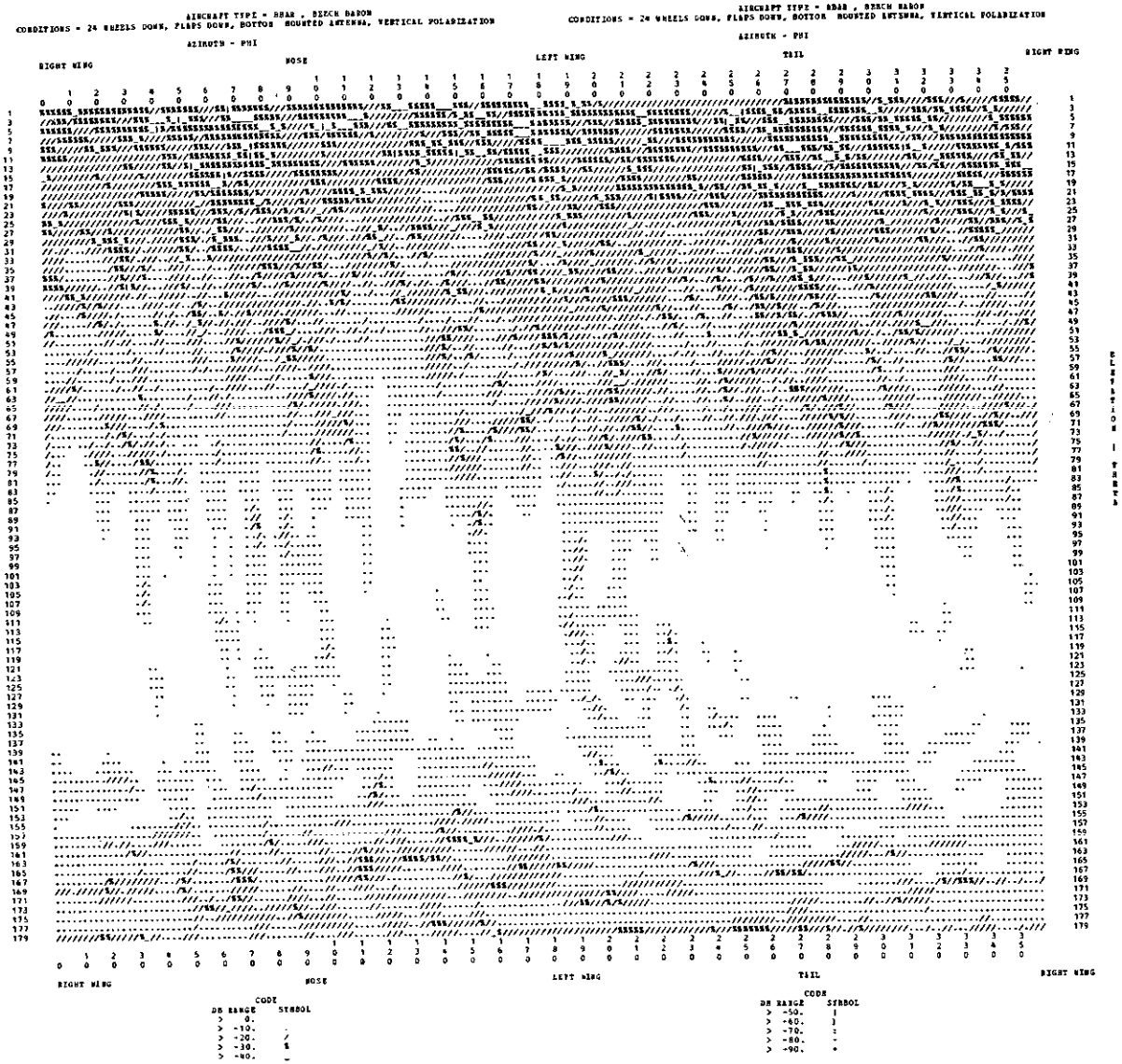

Fig. 5-13. Beechcraft Baron; antenna position 4 (B); wheels down, flaps down.

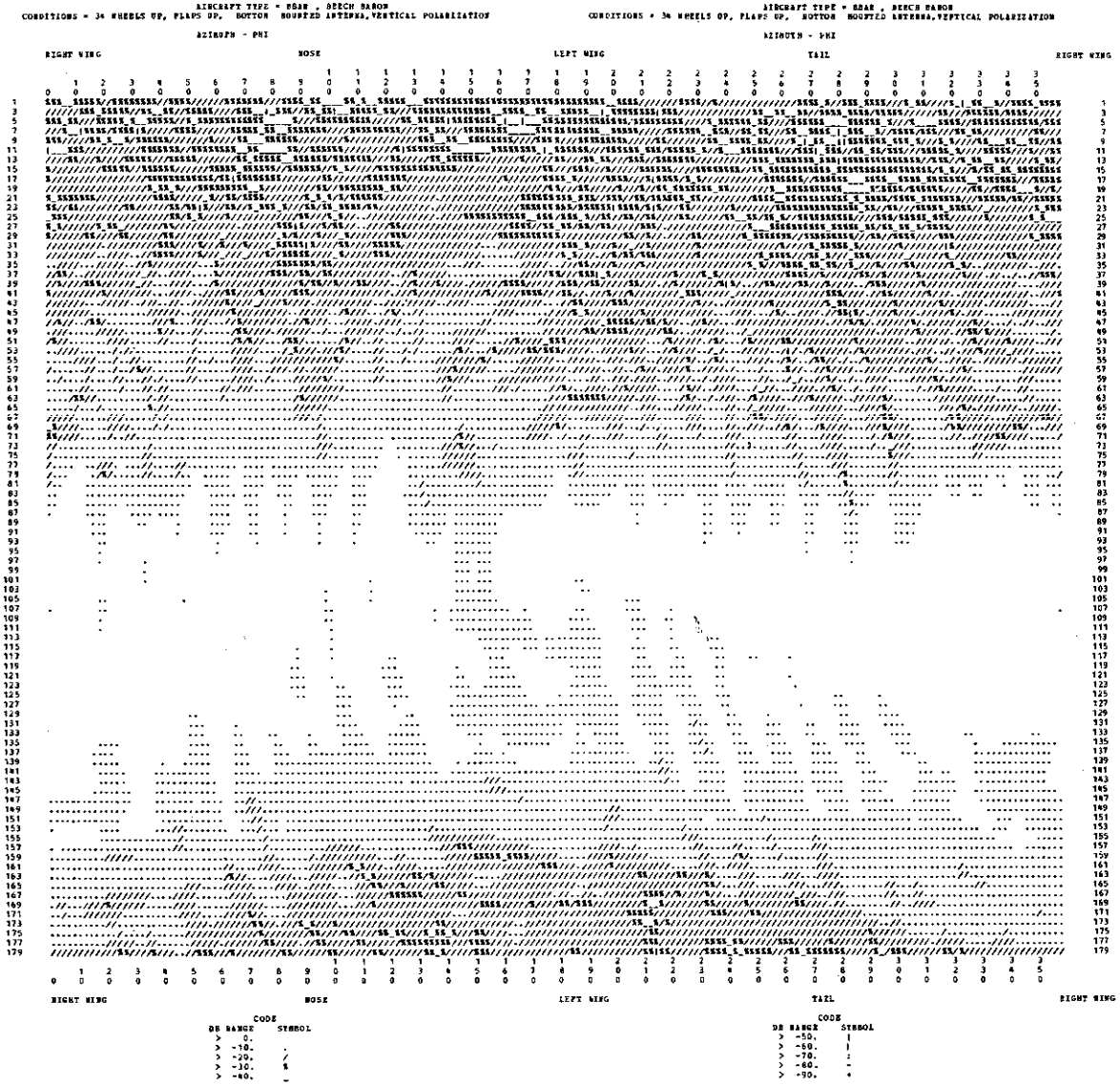

Fig. 5-14. Beechcraft Baron; antenna position 4 (B); wheels up, flaps up.

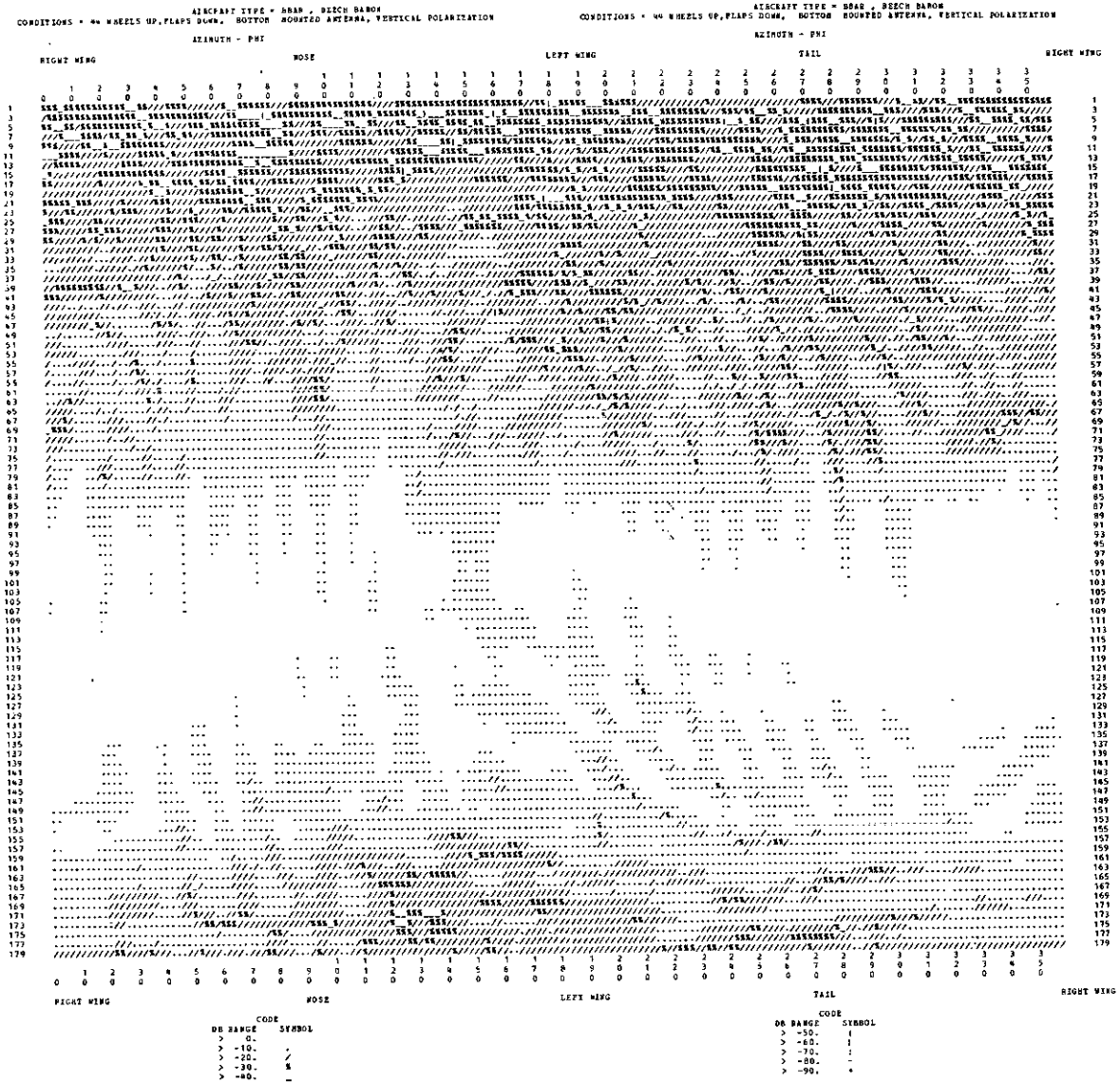

Fig. 5-15. Beechcraft Baron; antenna position 4 (B); wheels up, flaps down.

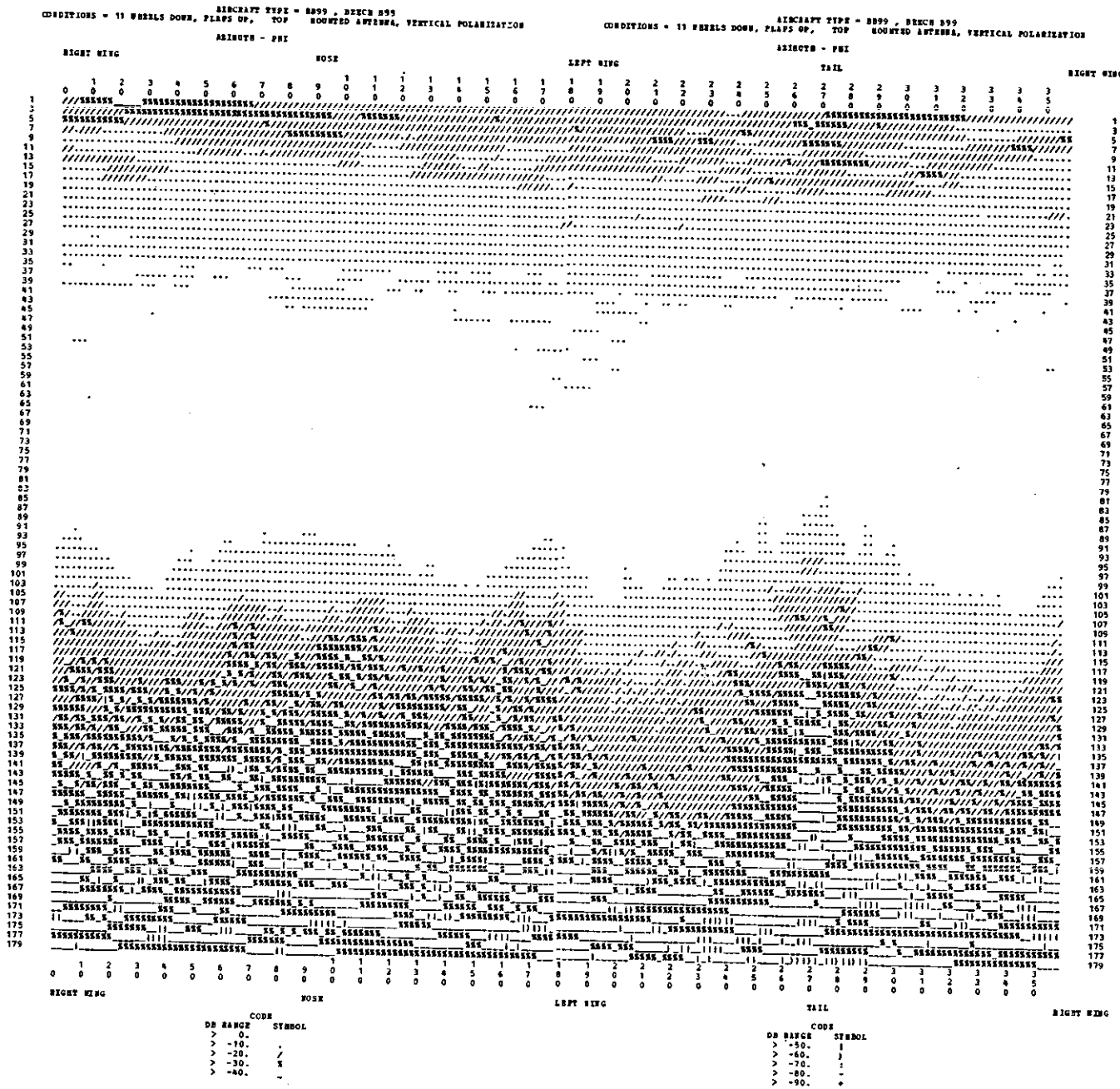

Fig. 6-1. Beechcraft Baron 99; antenna position 1 (T); wheels down, flaps up.

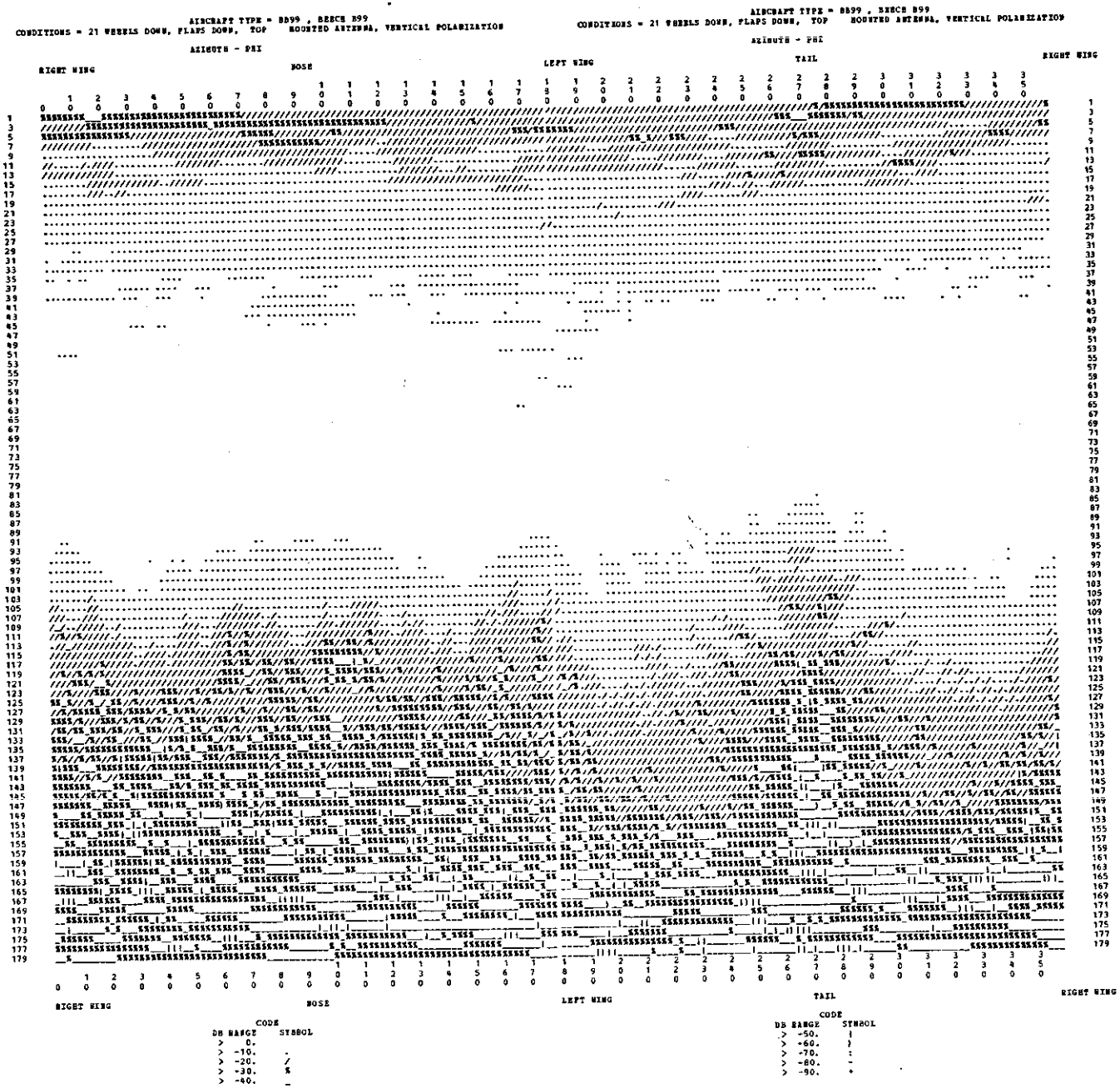

Fig. 6-2. Beechcraft Baron 99; antenna position 1 (T); wheels down, flaps down.

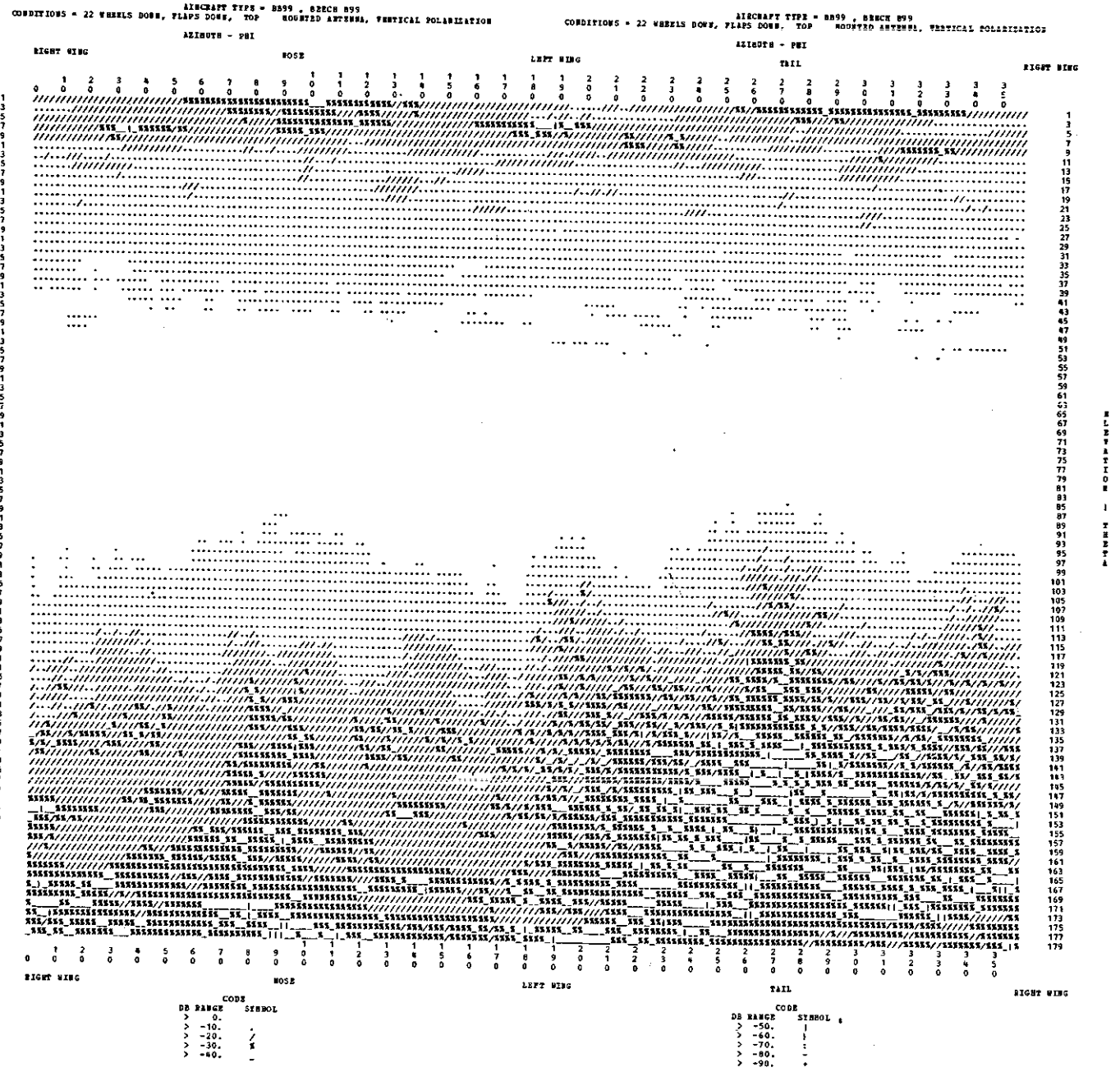

Fig. 6-3. Beechcraft Baron 99; antenna position 2 (T); wheels down, flaps down.

C45-1226

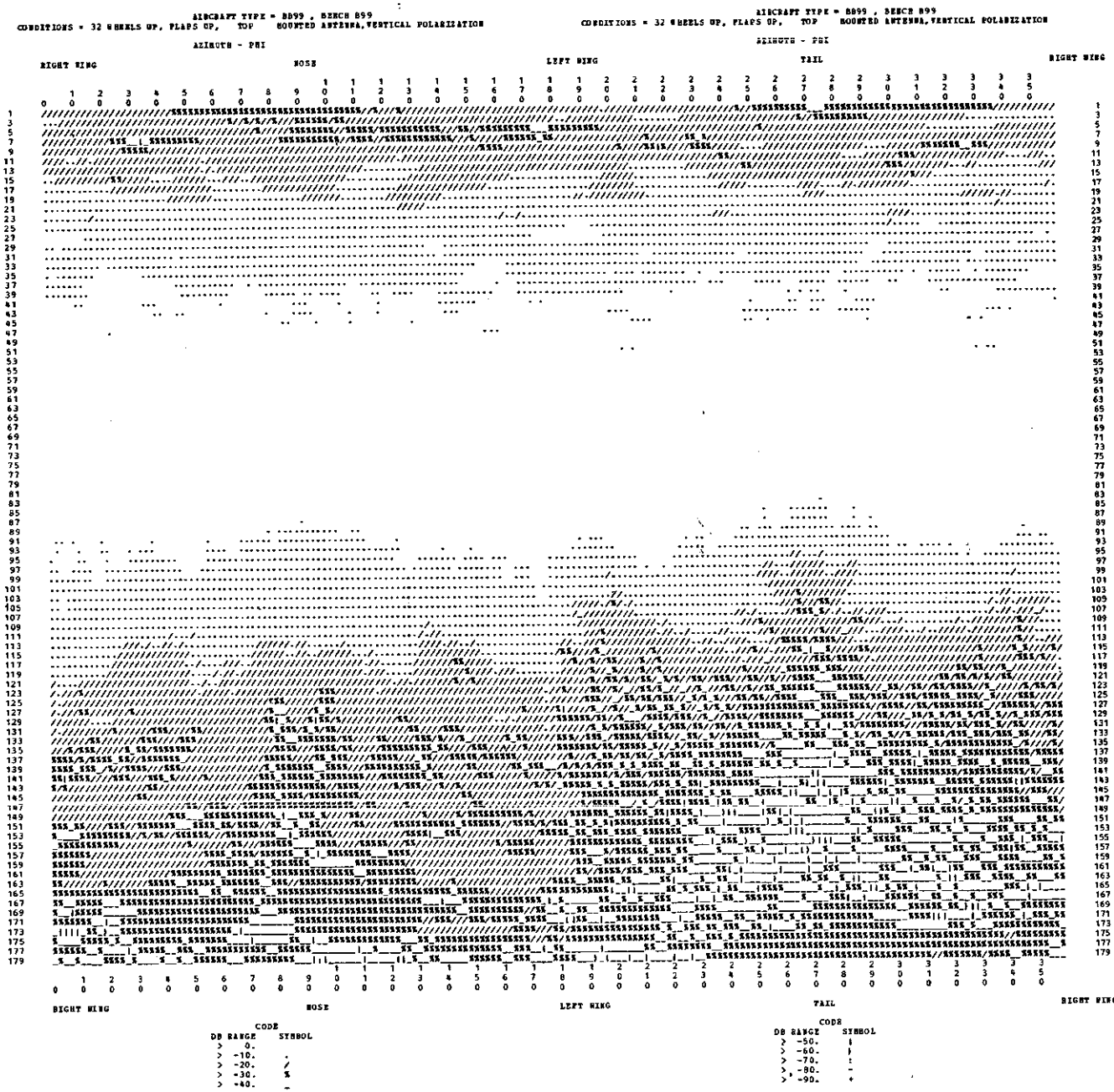

Fig. 6-4. Beechcraft Baron 99; antenna position 2 (T); wheels up, flaps up.

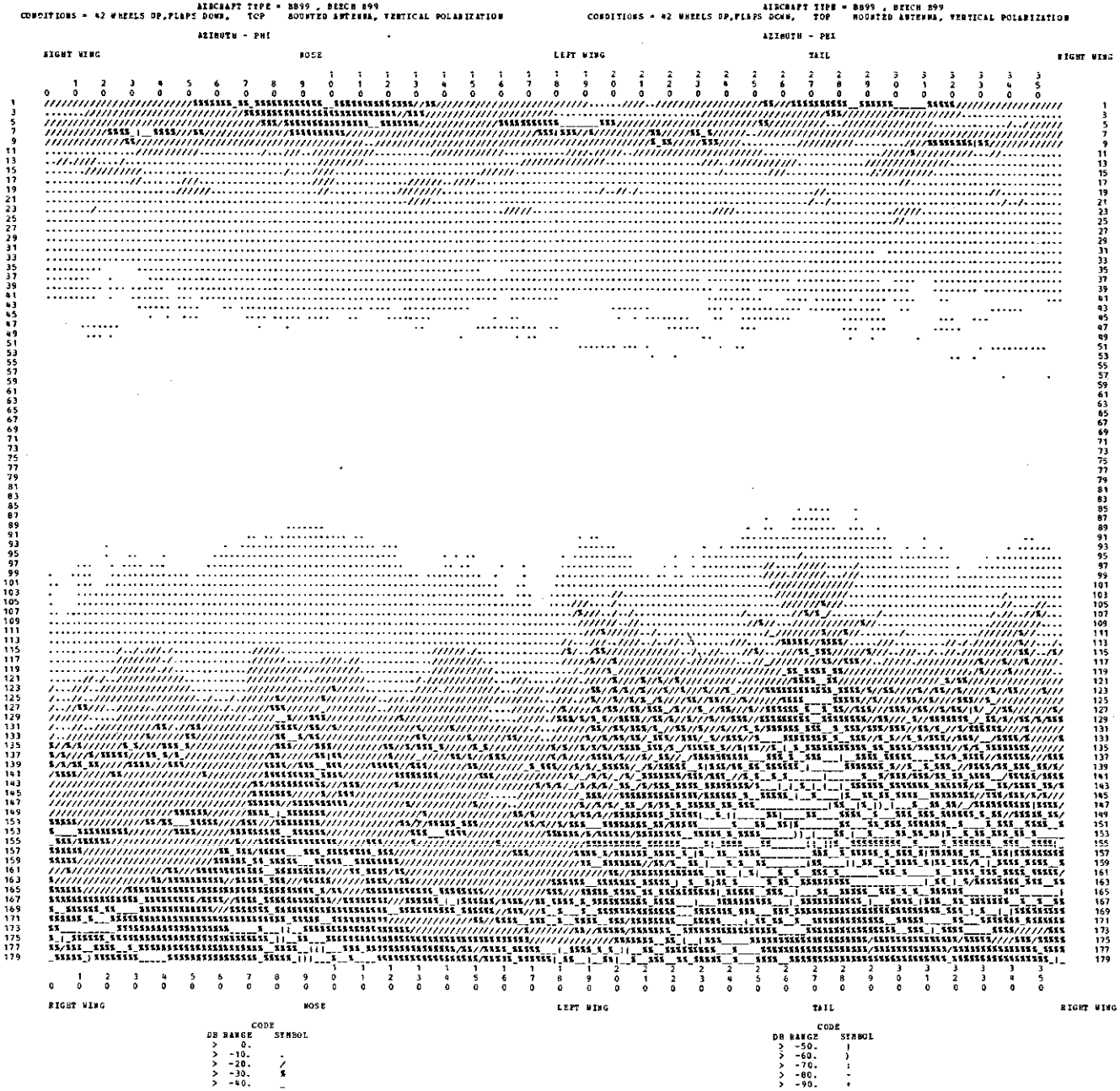

Fig. 6-5. Beechcraft Baron 99; antenna position 2 (T); wheels up, flaps down.

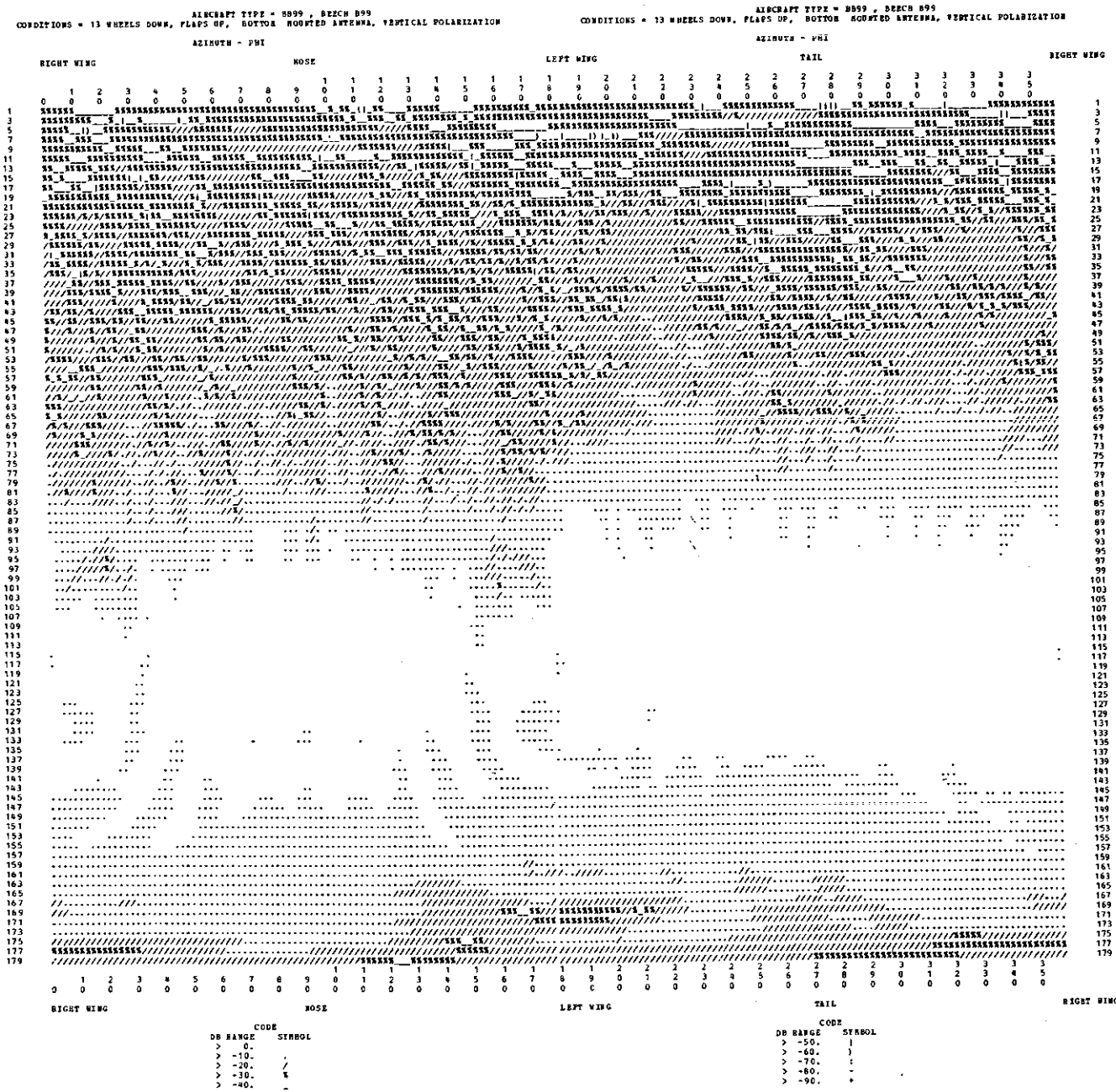

Fig. 6-6. Beechcraft Baron 99; antenna position 3 (B); wheels down, flaps up.

C45-12

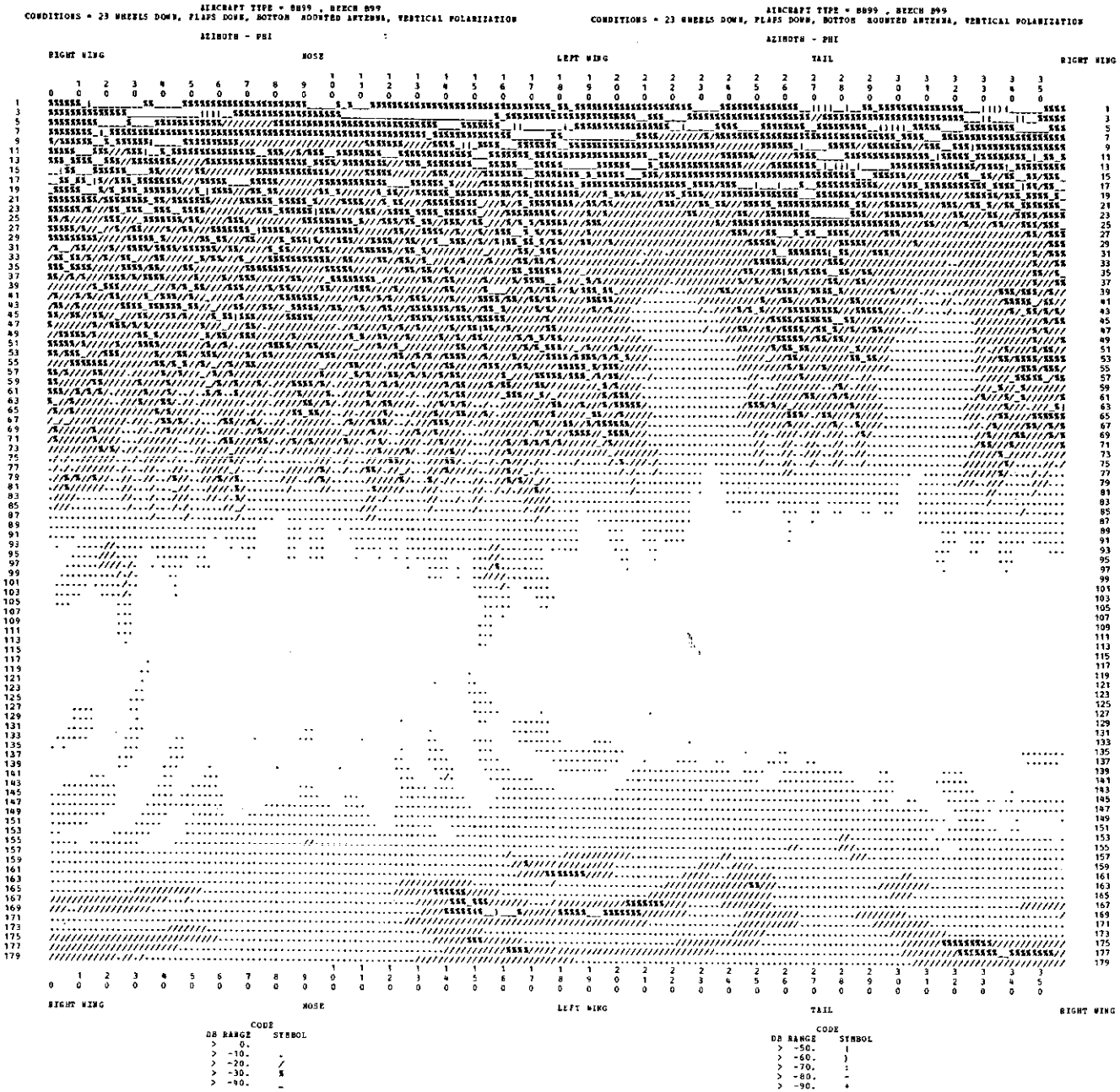

Fig. 6-7. Beechcraft Baron 99; antenna position 3 (B); wheels down, flaps down.

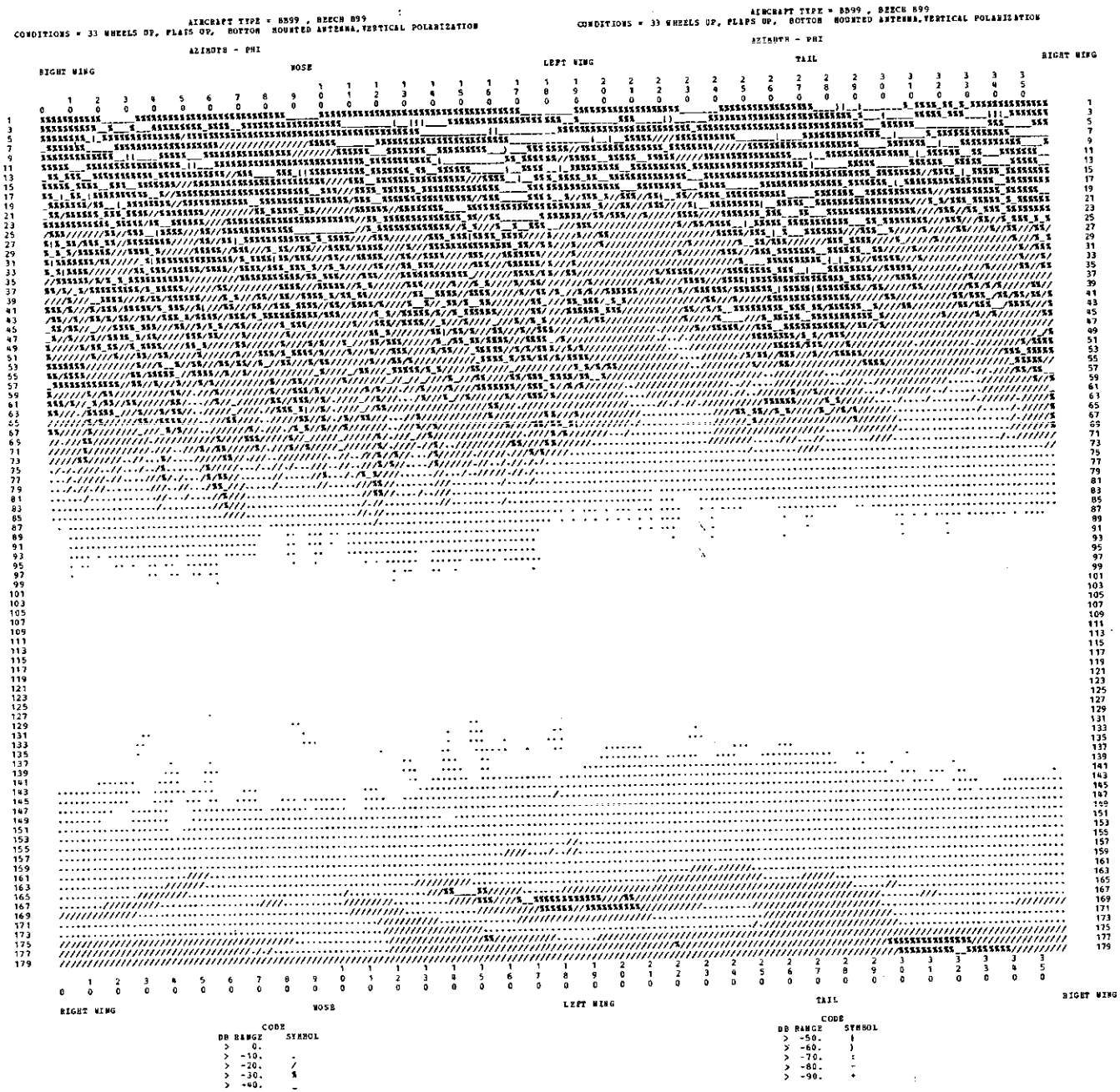

Fig. 6-8. Beechcraft Baron 99; antenna position 3 (B); wheels up, flaps up.

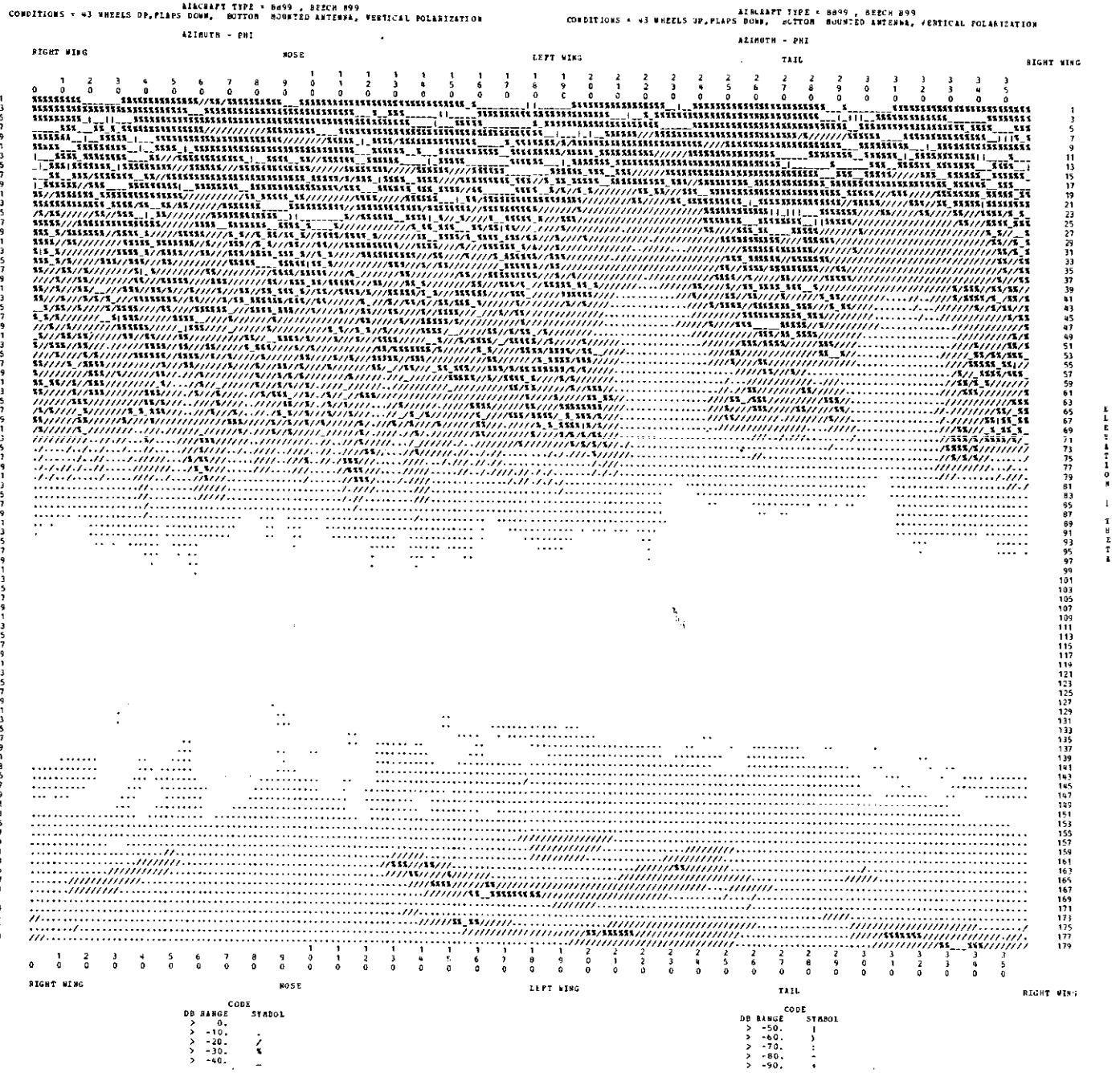

Fig. 6-9. Beechcraft Baron 99; antenna position 3 (B); wheels up, flaps down.

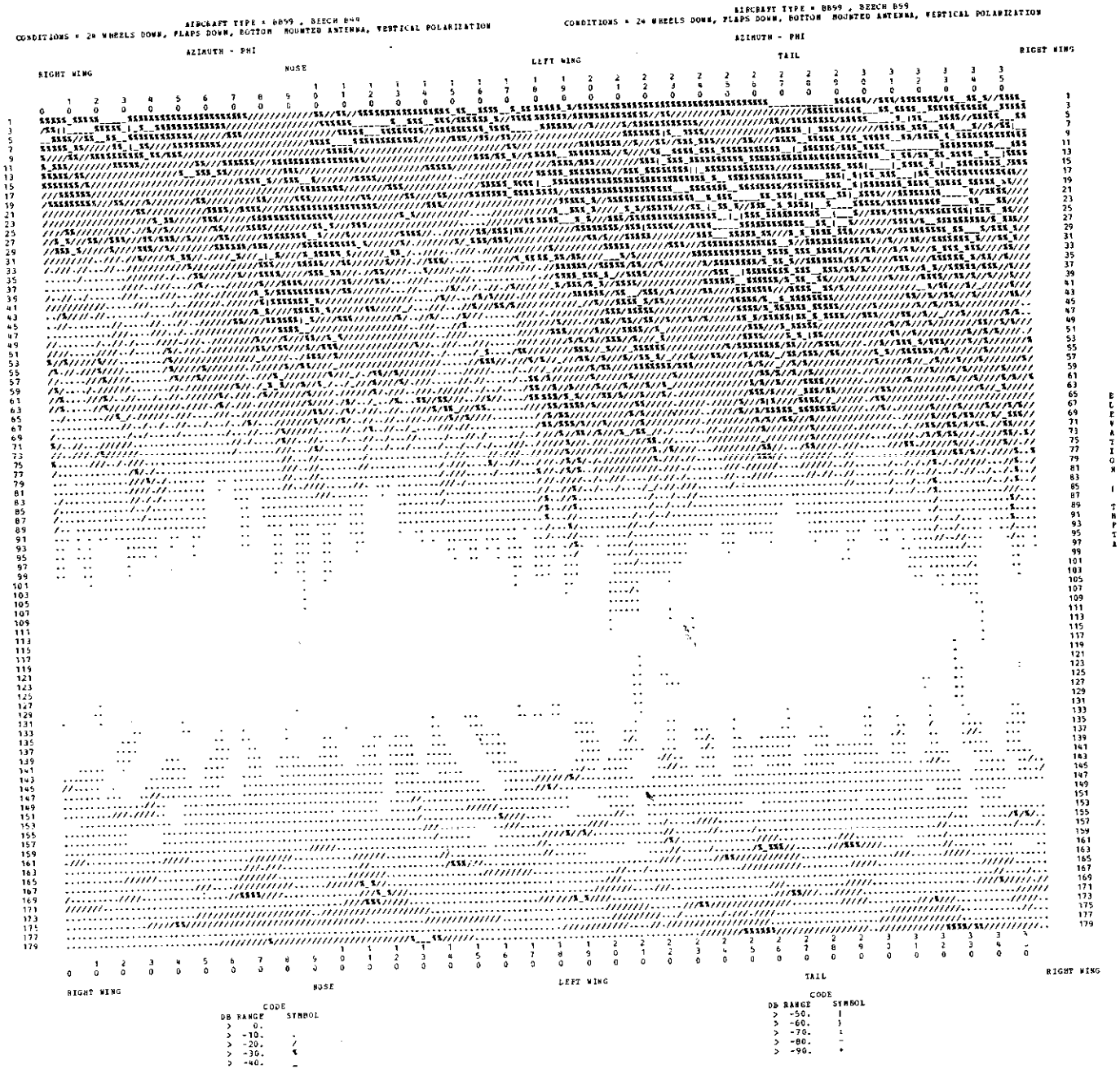

Fig. 6-11. Beechcraft Baron 99; antenna position 4 (B); wheels down, flaps down.

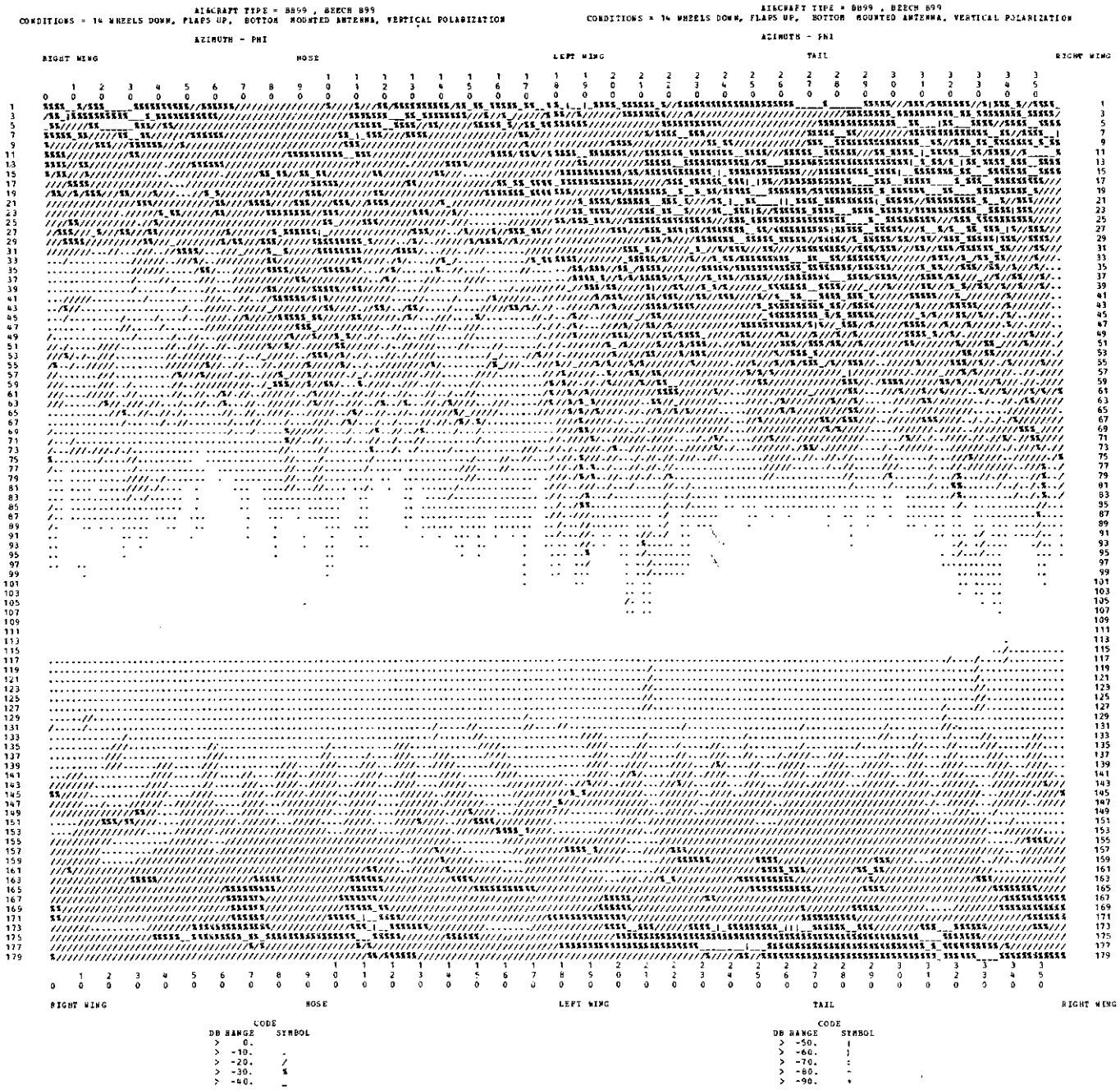

Fig. 6-10. Beechcraft Baron 99; antenna position 4 (B); wheels down, flaps up.

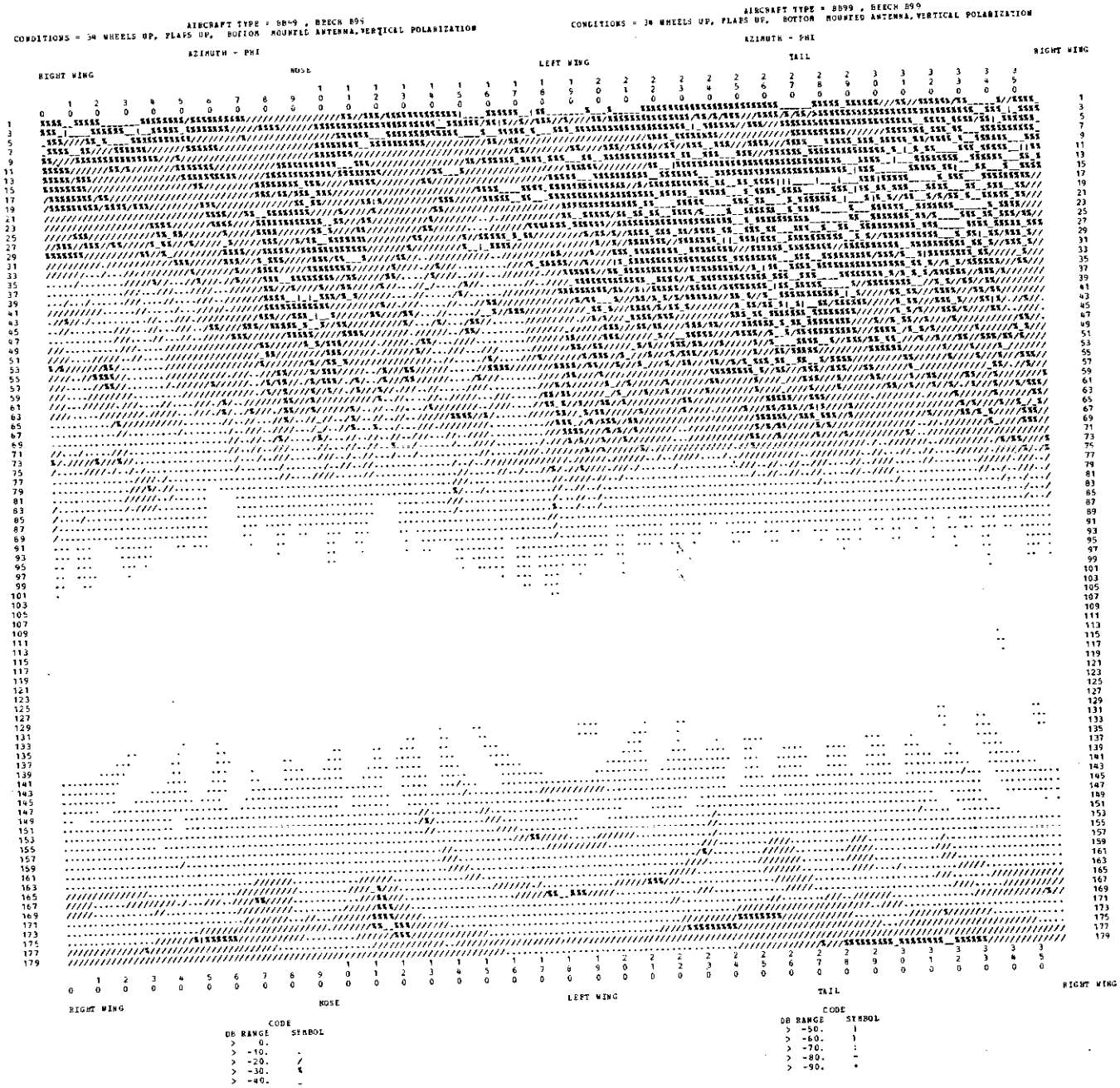

Fig. 6-12. Beechcraft Baron 99; antenna position 4 (B); wheels up, flaps up.

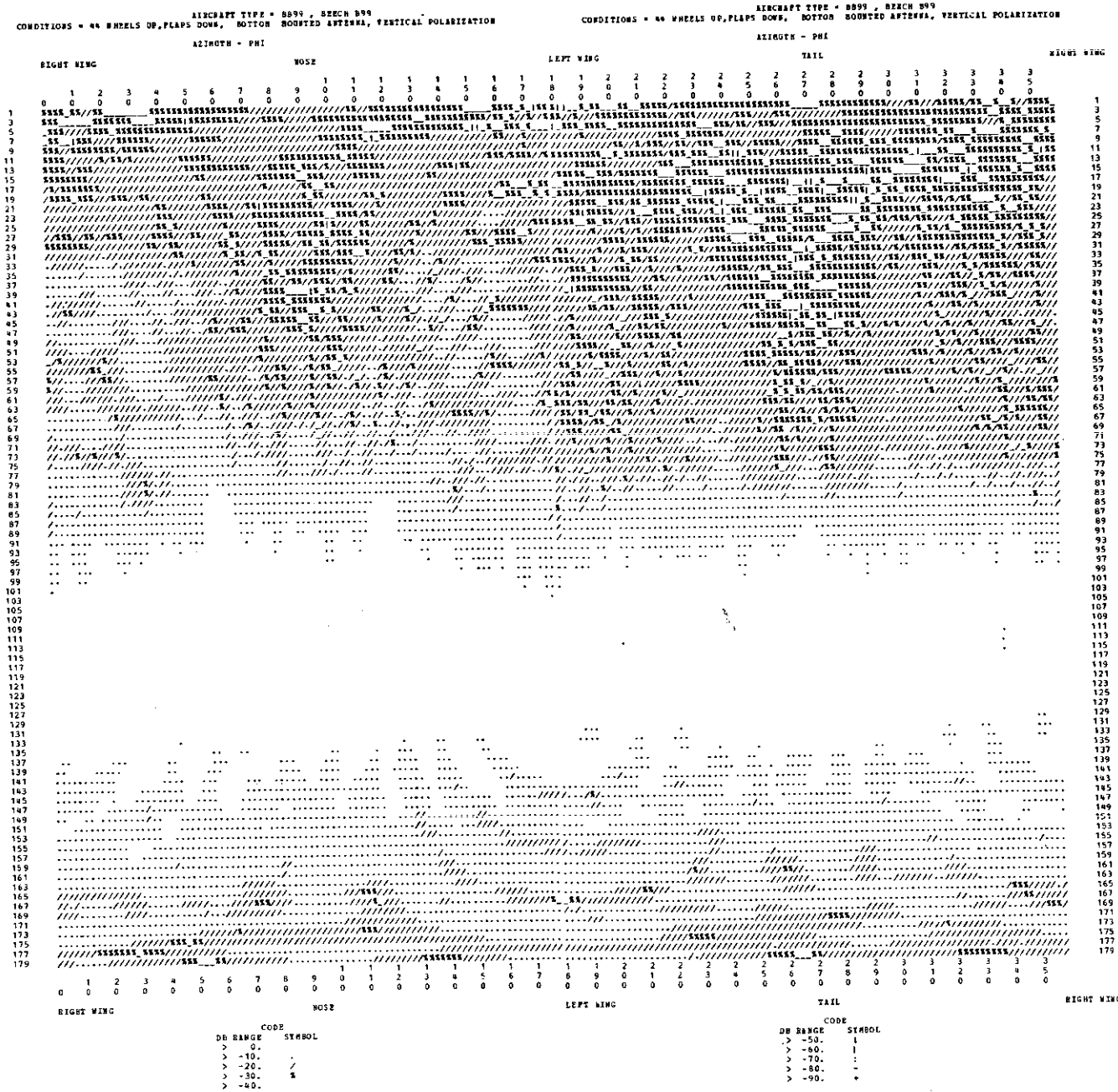

Fig. 6-13. Beechcraft Baron 99; antenna position 4 (B); wheels up, flaps down.

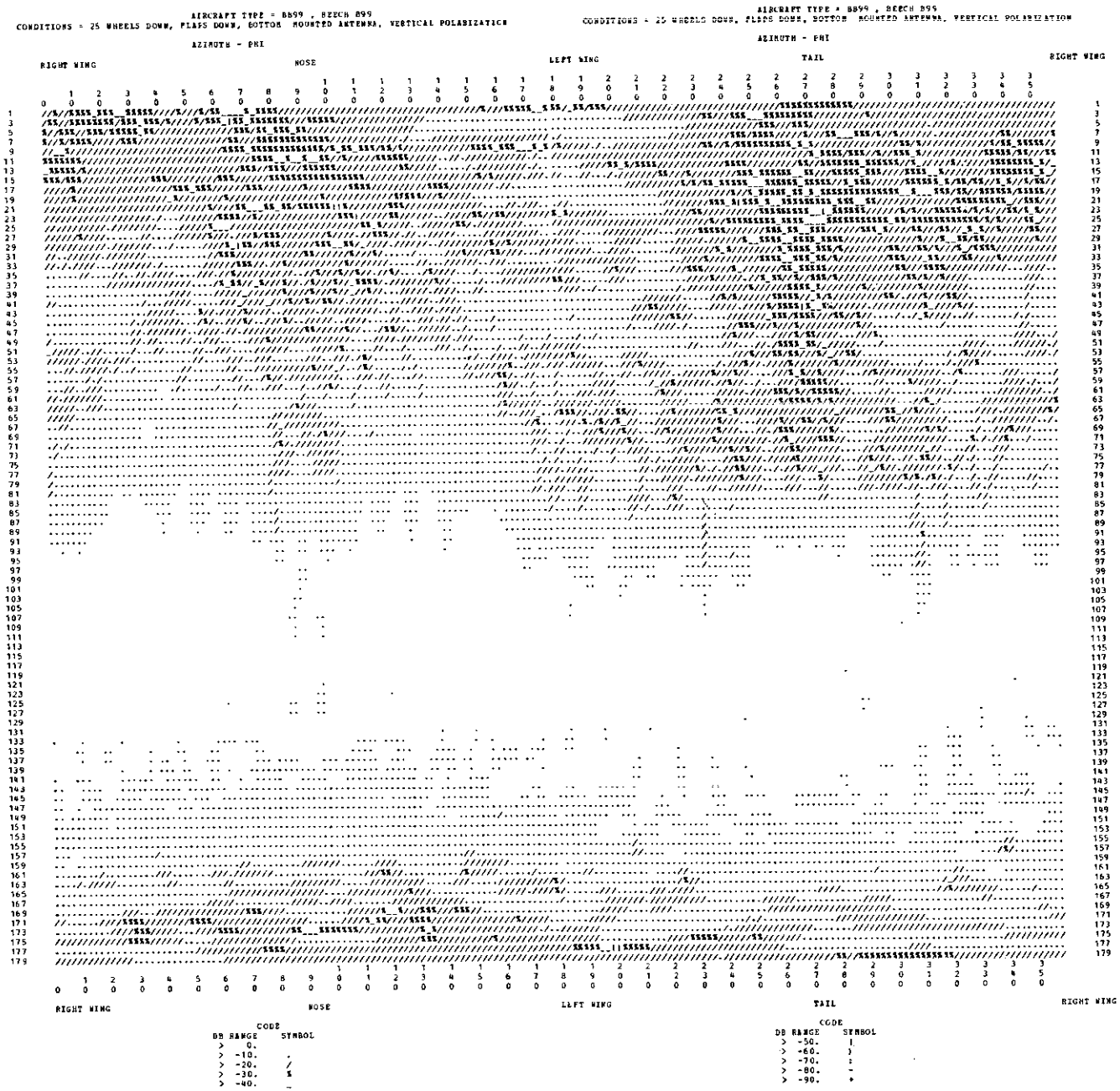

Fig. 6-14. Beechcraft Baron 99; antenna position 5 (B); wheels down, flaps down.

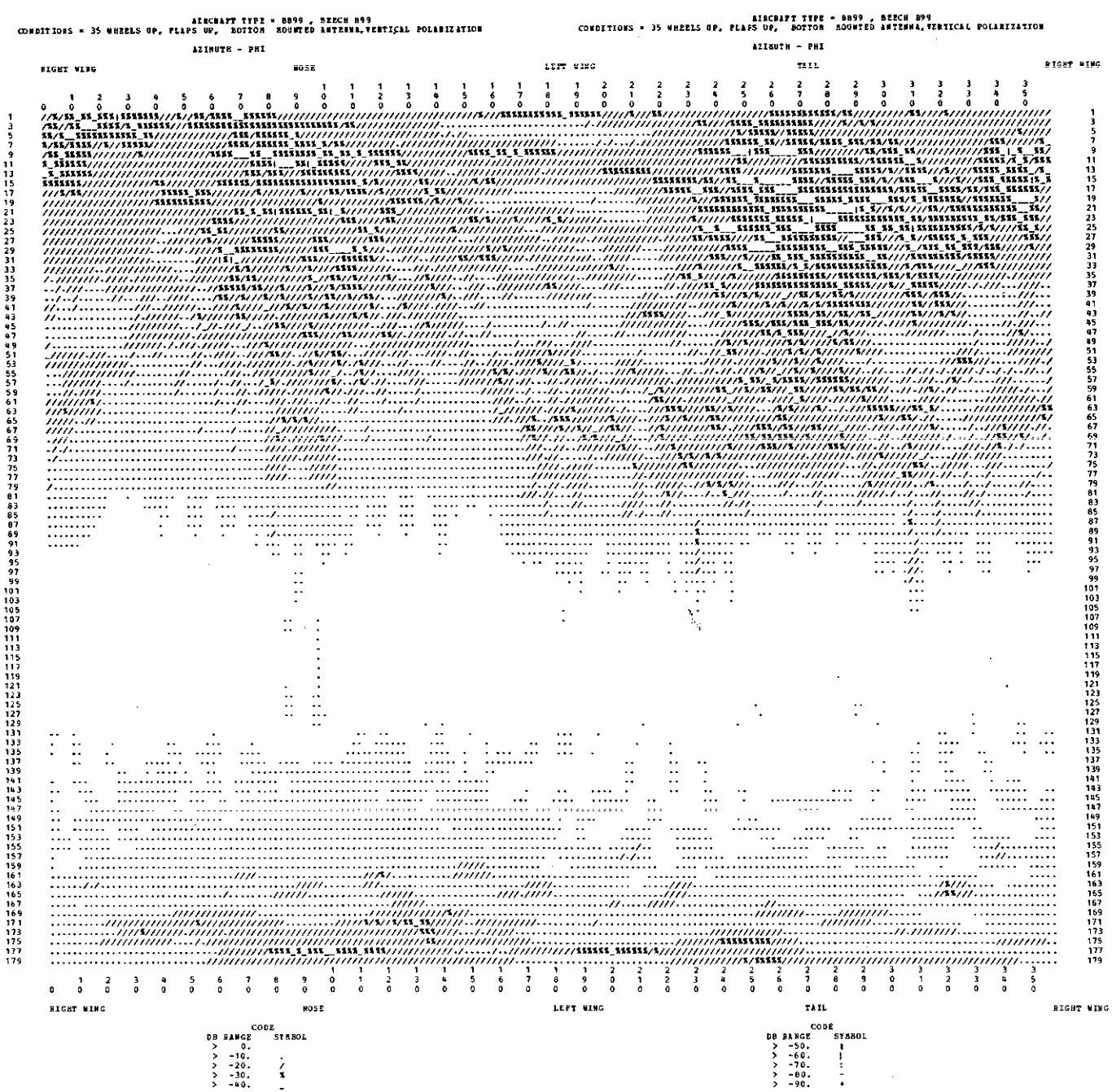

Fig. 6-15. Beechcraft Baron 99; antenna position 5 (B); wheels up, flaps up.

C45-1238

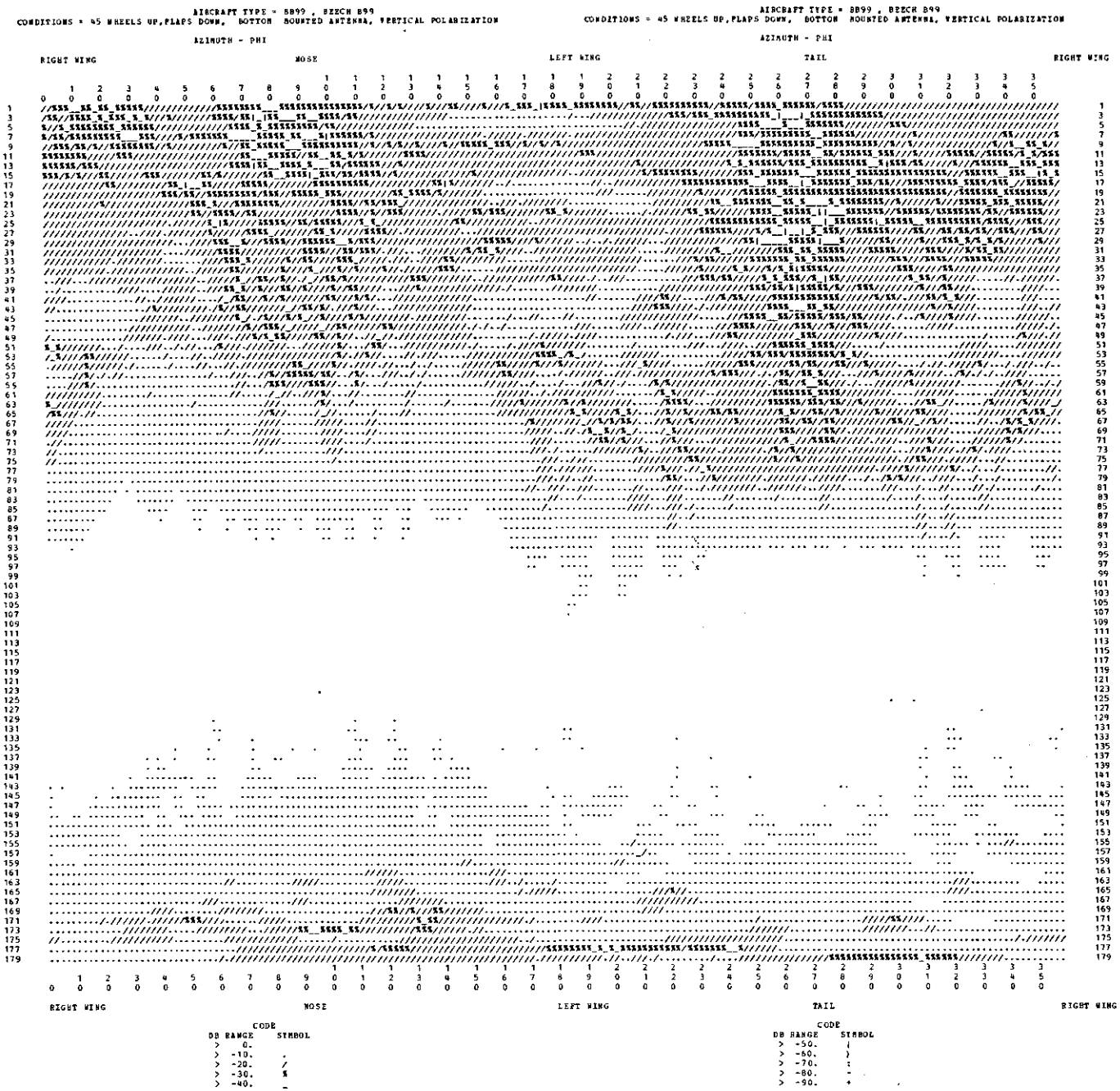

Fig. 6-16. Beechcraft Baron 99; antenna position 5 (B); wheels up, flaps down.

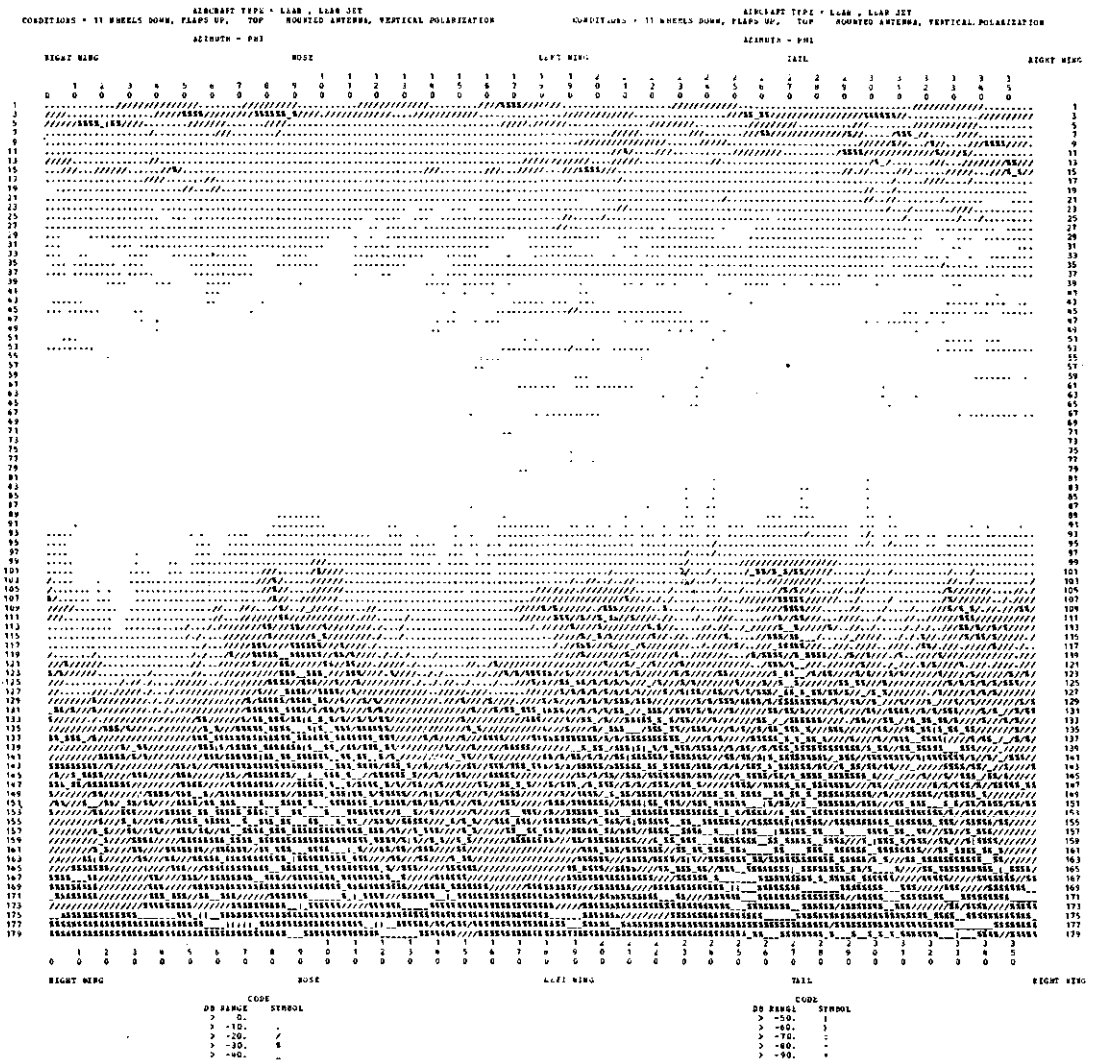

Fig. 7-1. Gates Lear jet; antenna position 1 (T); wheels down, flaps up.

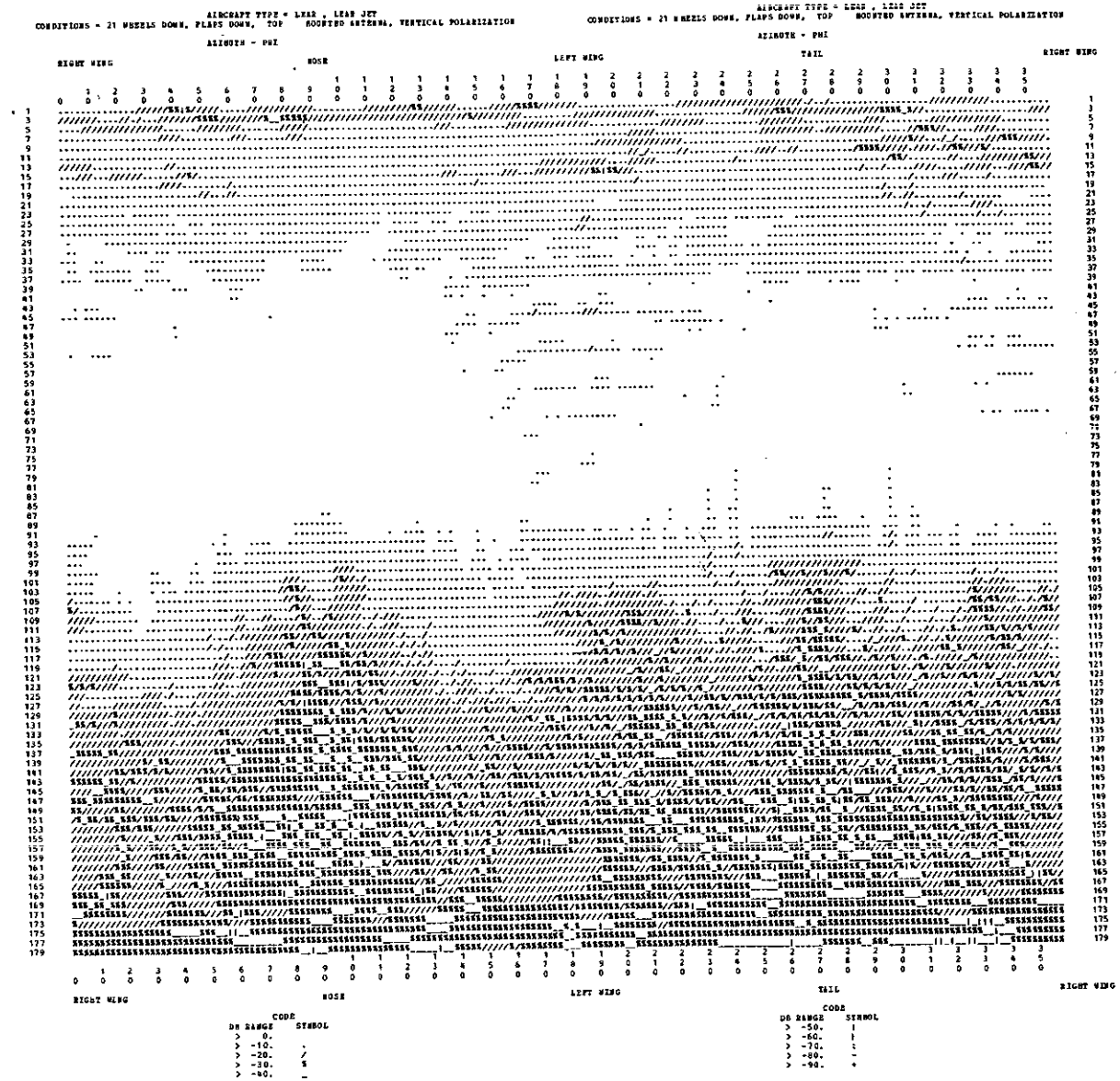

Fig. 7-2. Gates Lear jet; antenna position 1 (T); wheels down, flaps down.

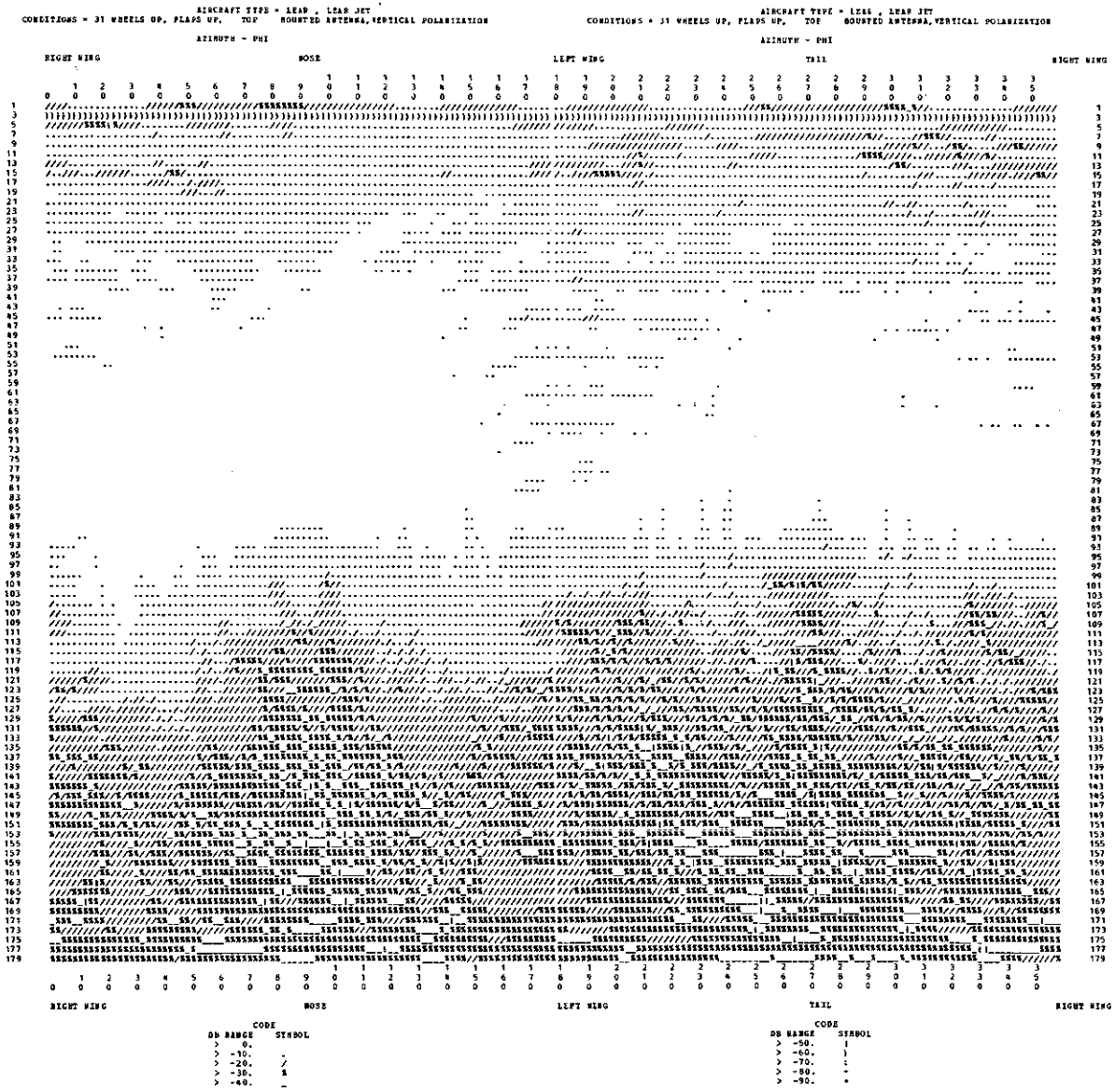

Fig. 7-3. Gates Lear jet; antenna position 1 (T); wheels up, flaps up.

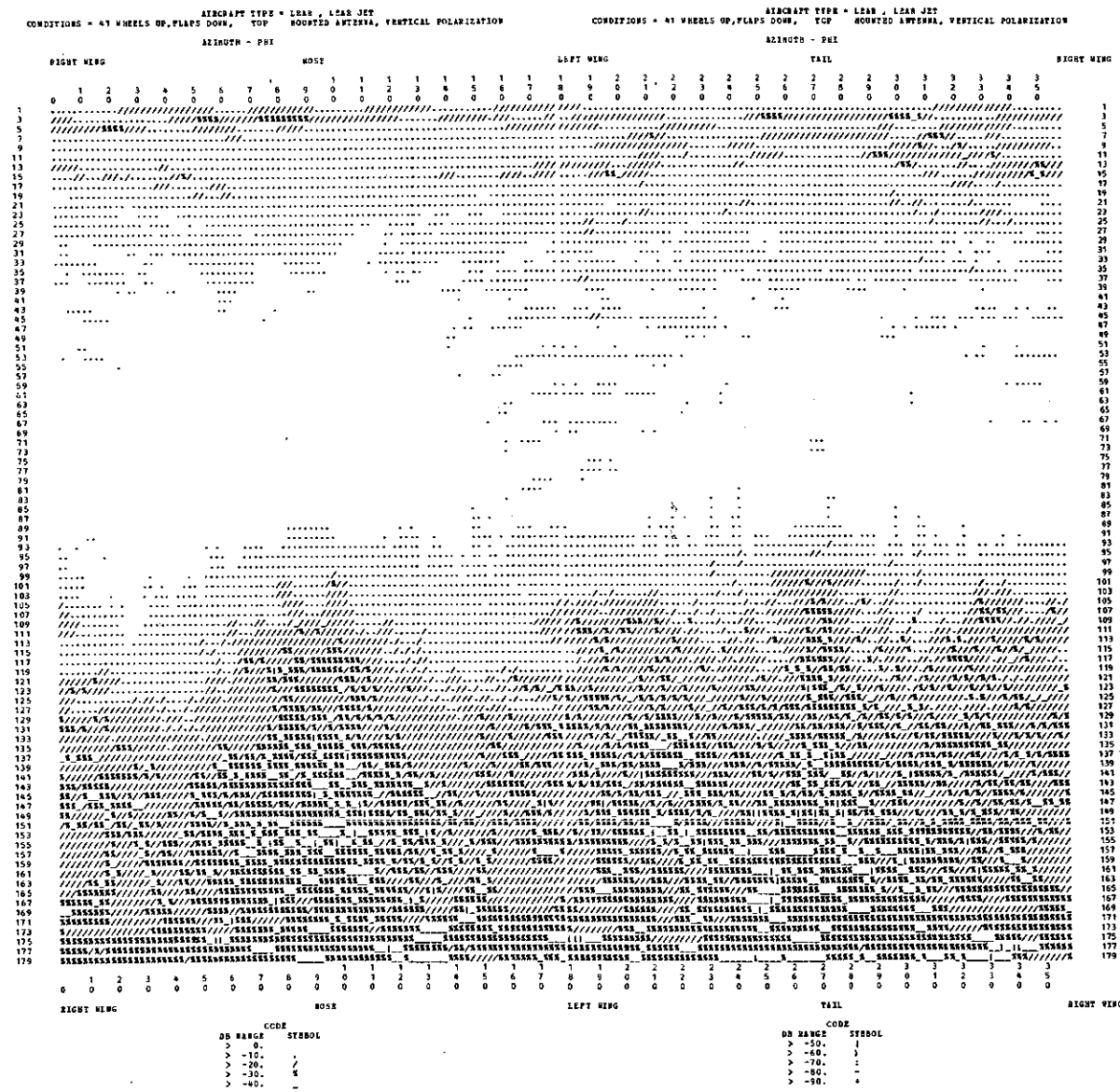

Fig. 7-4. Gates Lear jet; antenna position 1 (T); wheels up, flaps down.

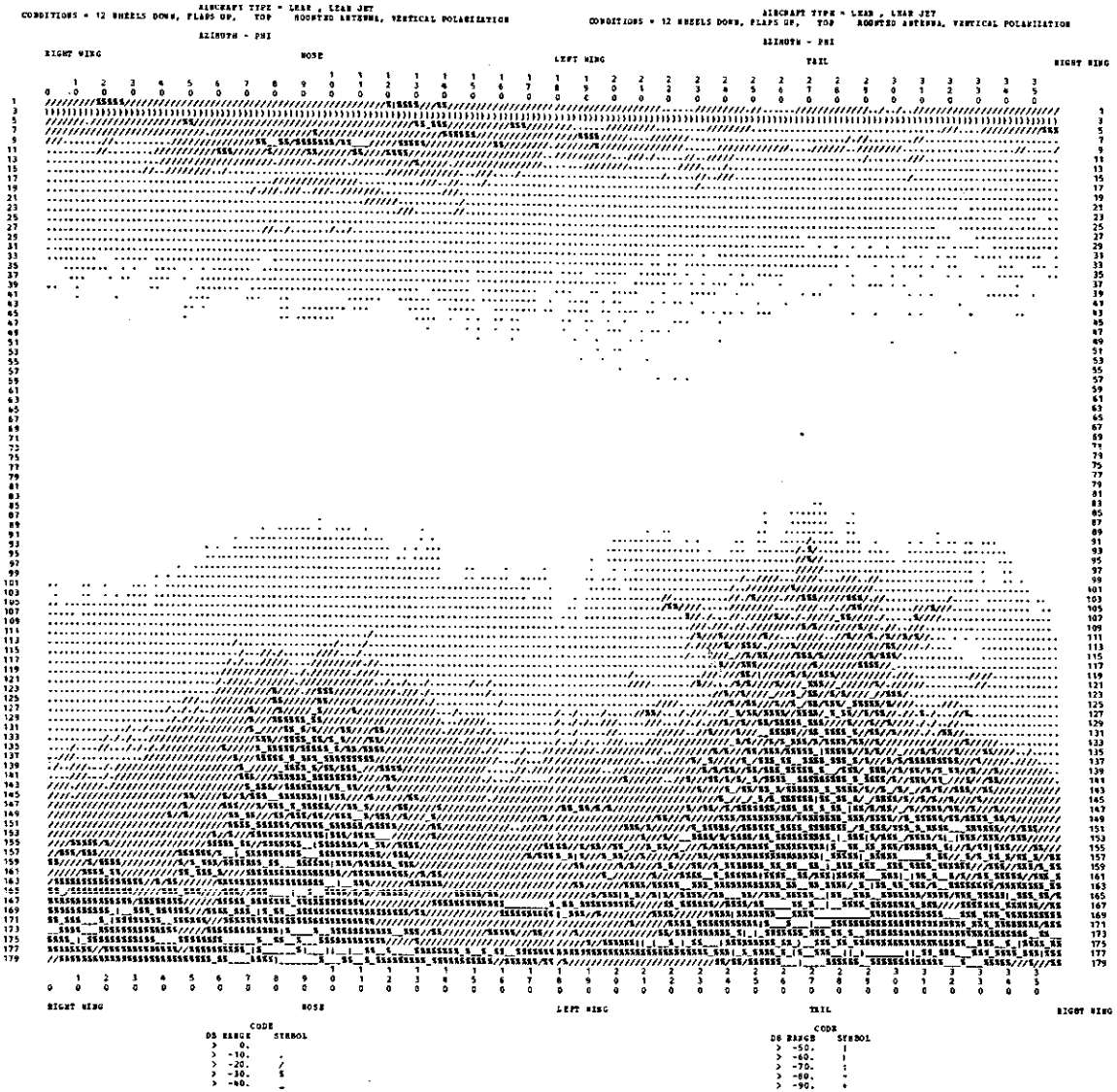

Fig. 7-5. Gates Lear jet; antenna position 2 (T); wheels down, flaps up.

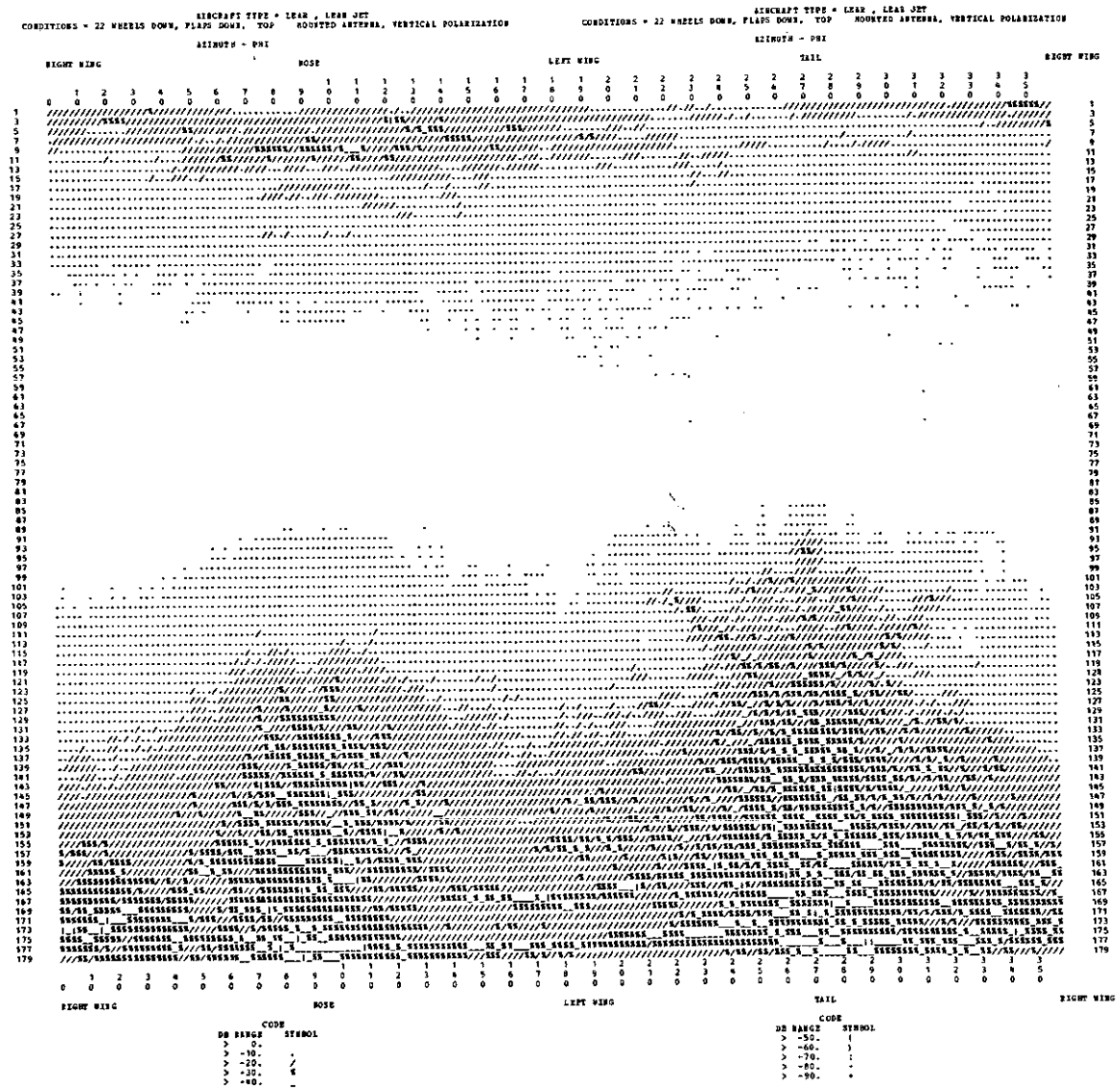

Fig. 7-6. Gates Lear jet; antenna position 2 (T); wheels down, flaps down.

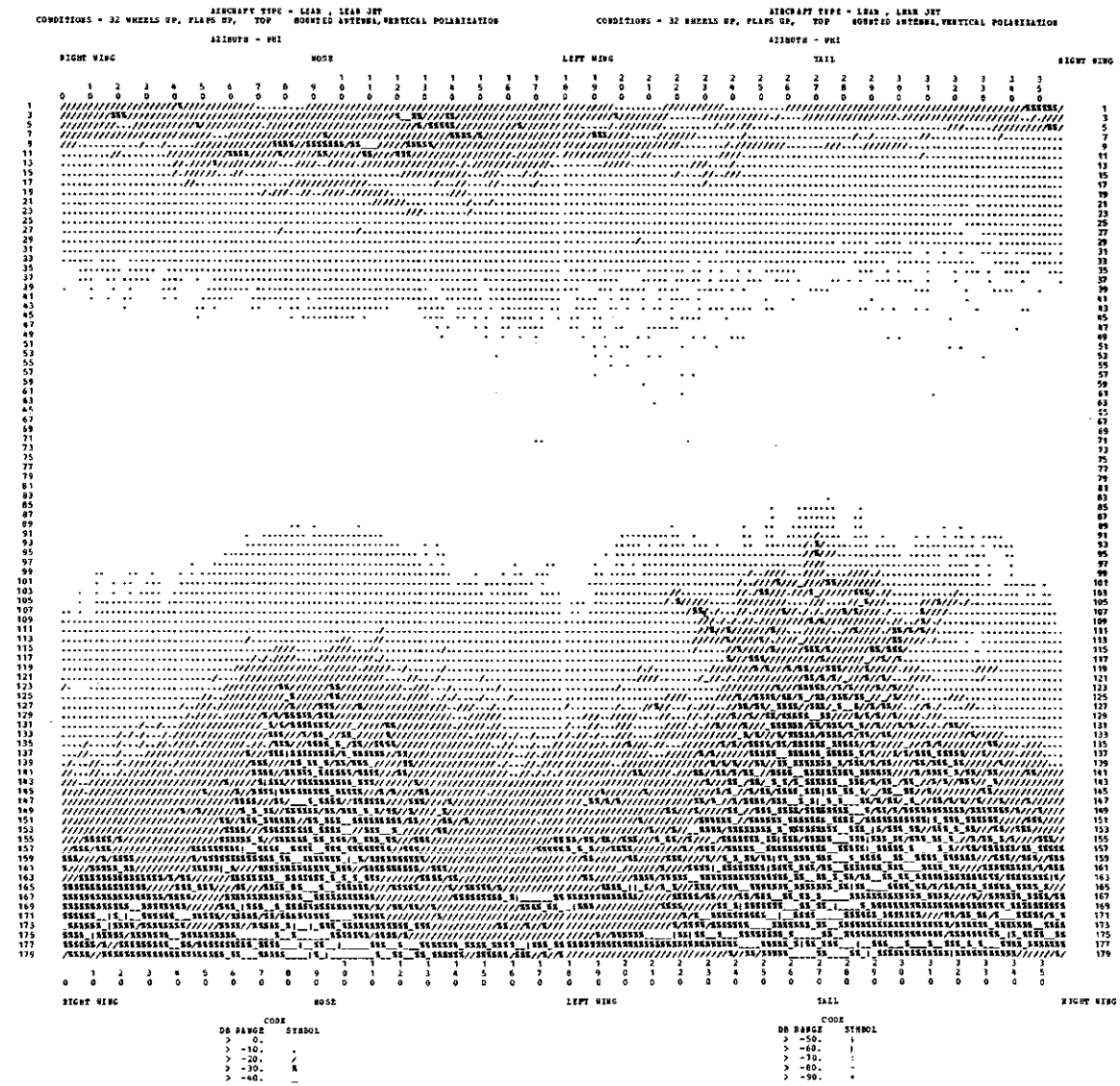

Fig. 7-7. Gates Lear jet; antenna position 2 (T); wheels up, flaps up.

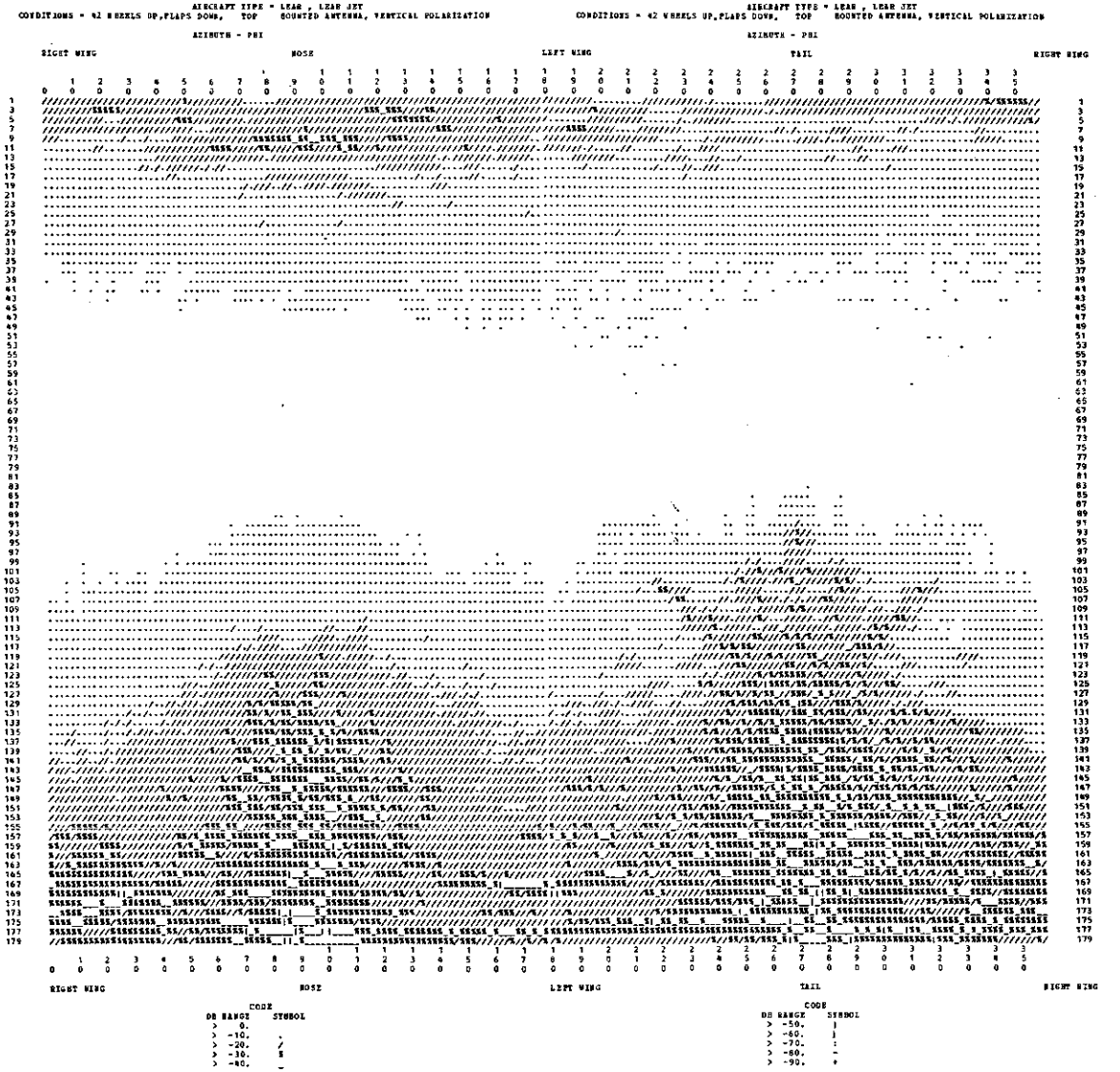

Fig. 7-8. Gates Lear jet; antenna position 2 (T); wheels down, flaps down.

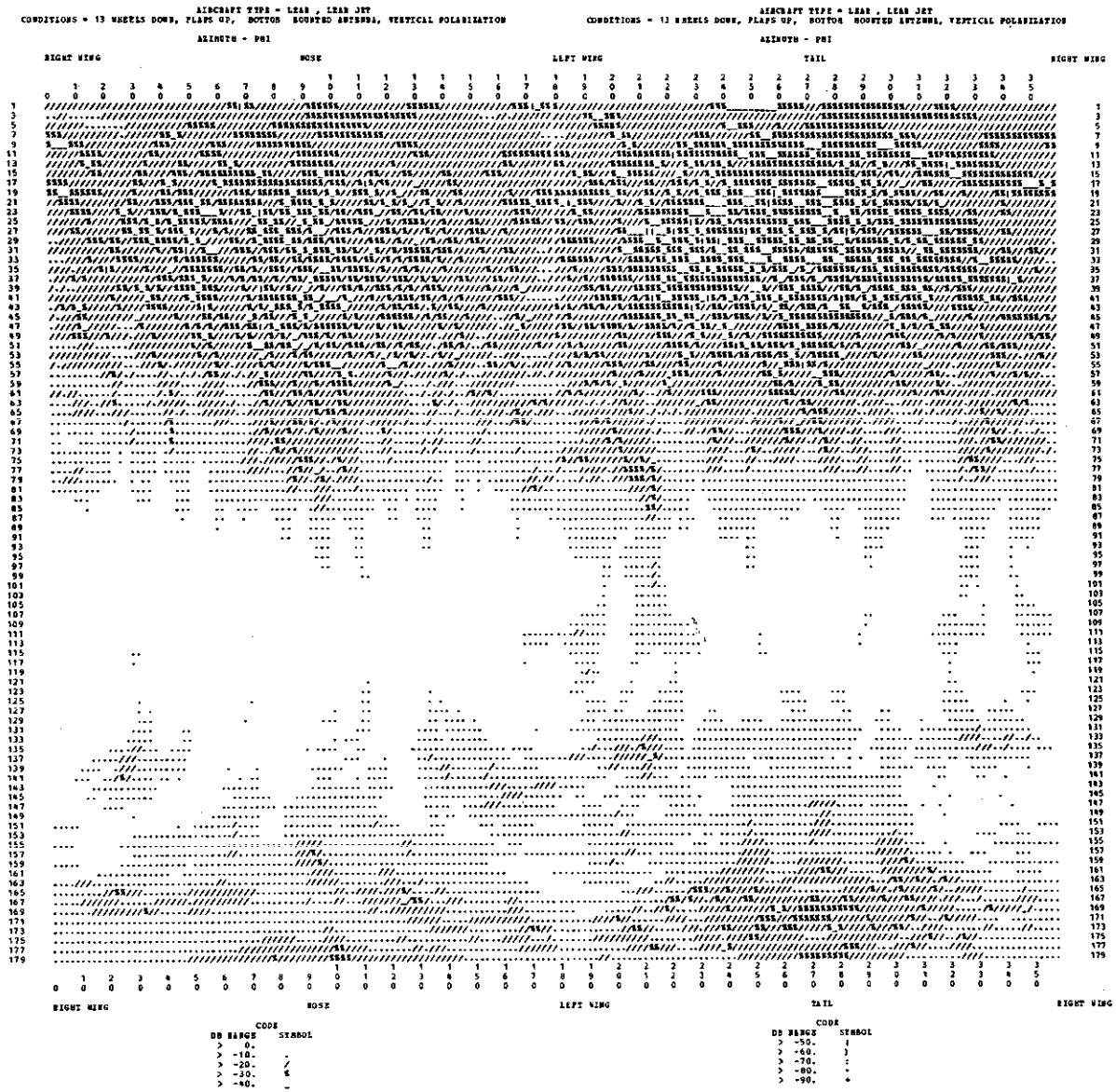

Fig. 7-9. Gates Lear jet; antenna position 3 (B); wheels down, flaps up.

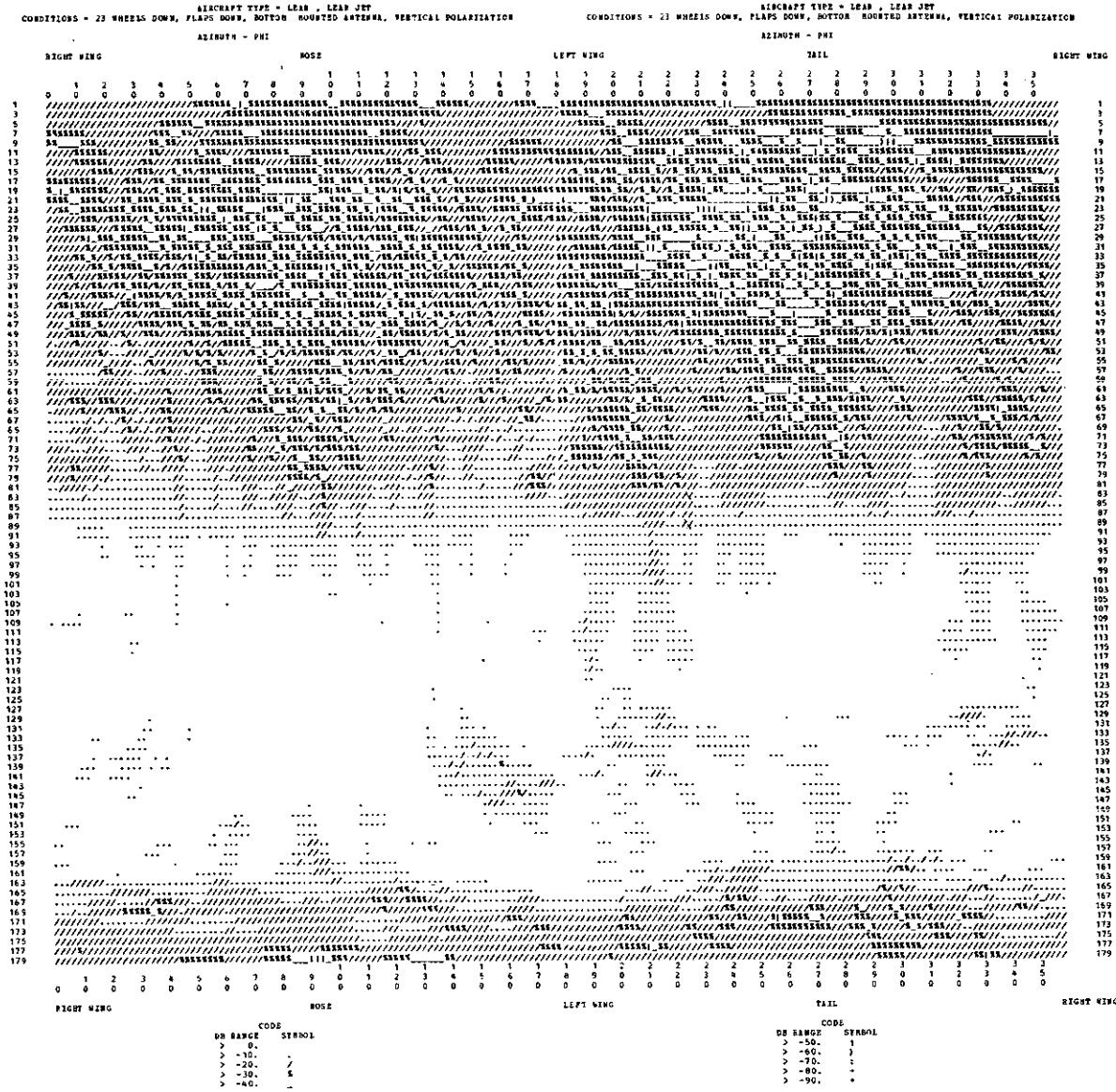

Fig. 7-10. Gates Lear jet; antenna position 3 (B); wheels down, flaps down.

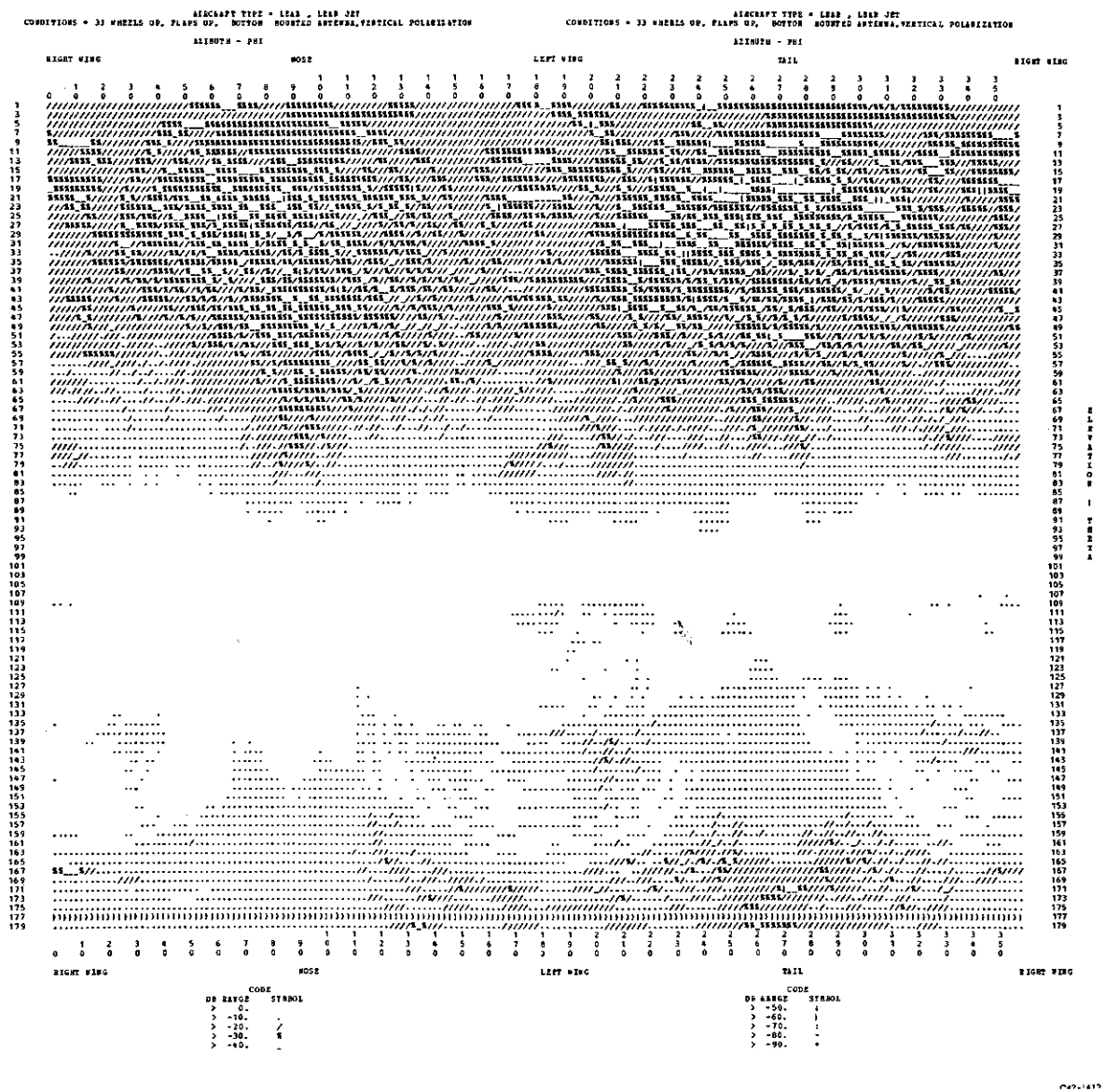

Fig. 7-11. Gates Lear jet; antenna position 3 (B); wheels up, flaps up.

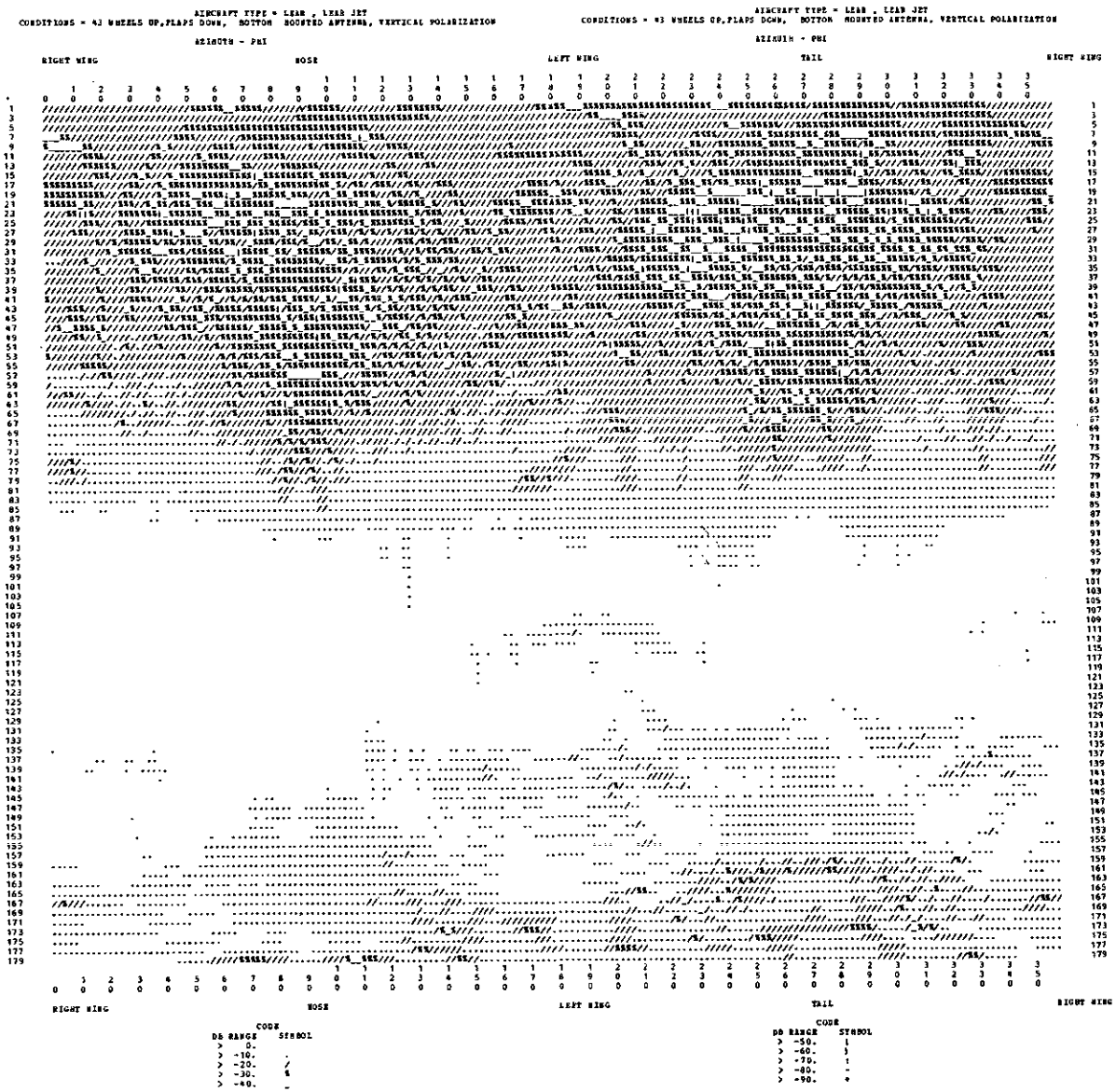

Fig. 7-12. Gates Lear jet; antenna position 3 (B); wheels up, flaps down.

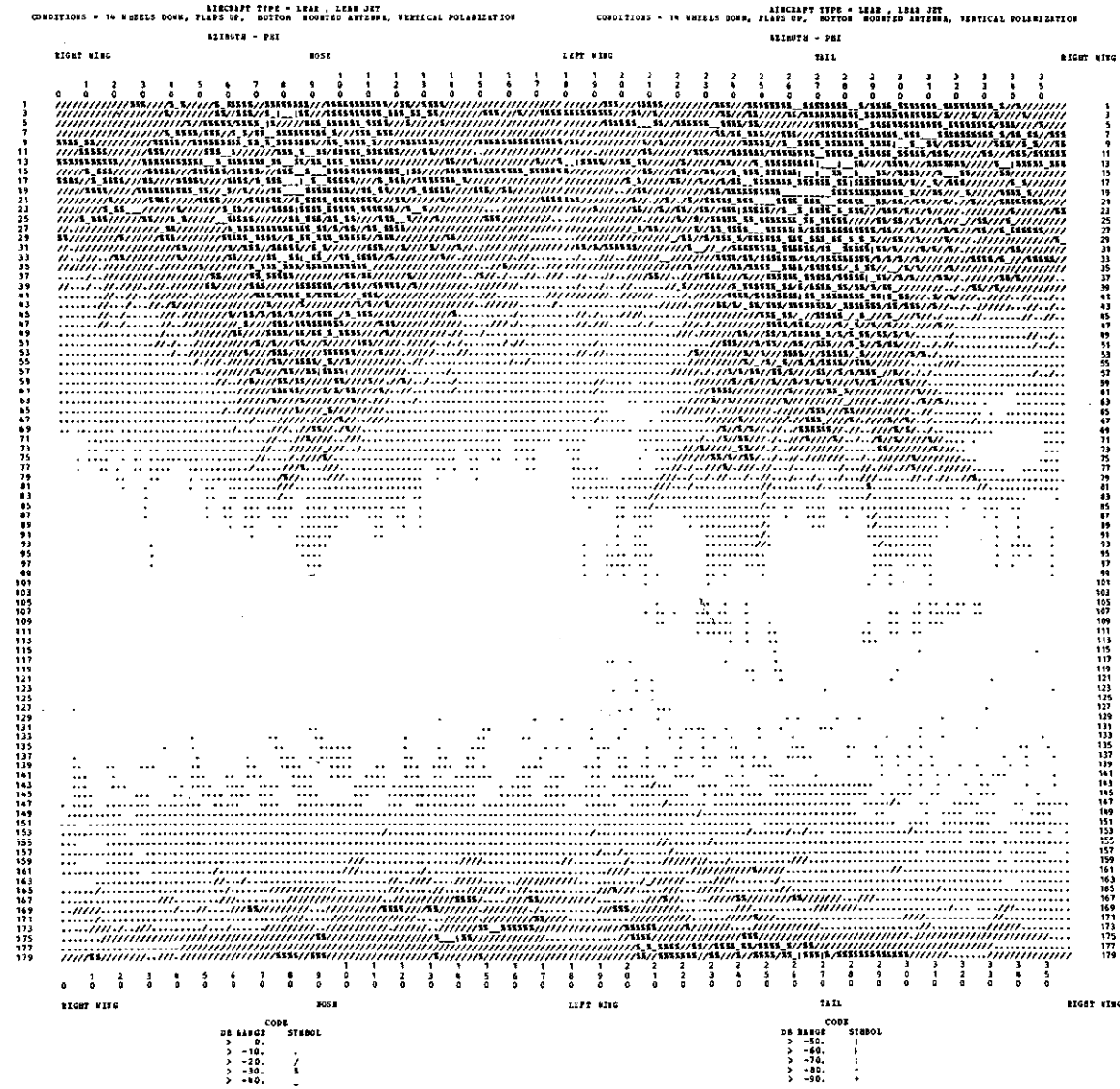

Fig. 7-13. Gates Lear jet; antenna position 4 (B); wheels down, flaps up.

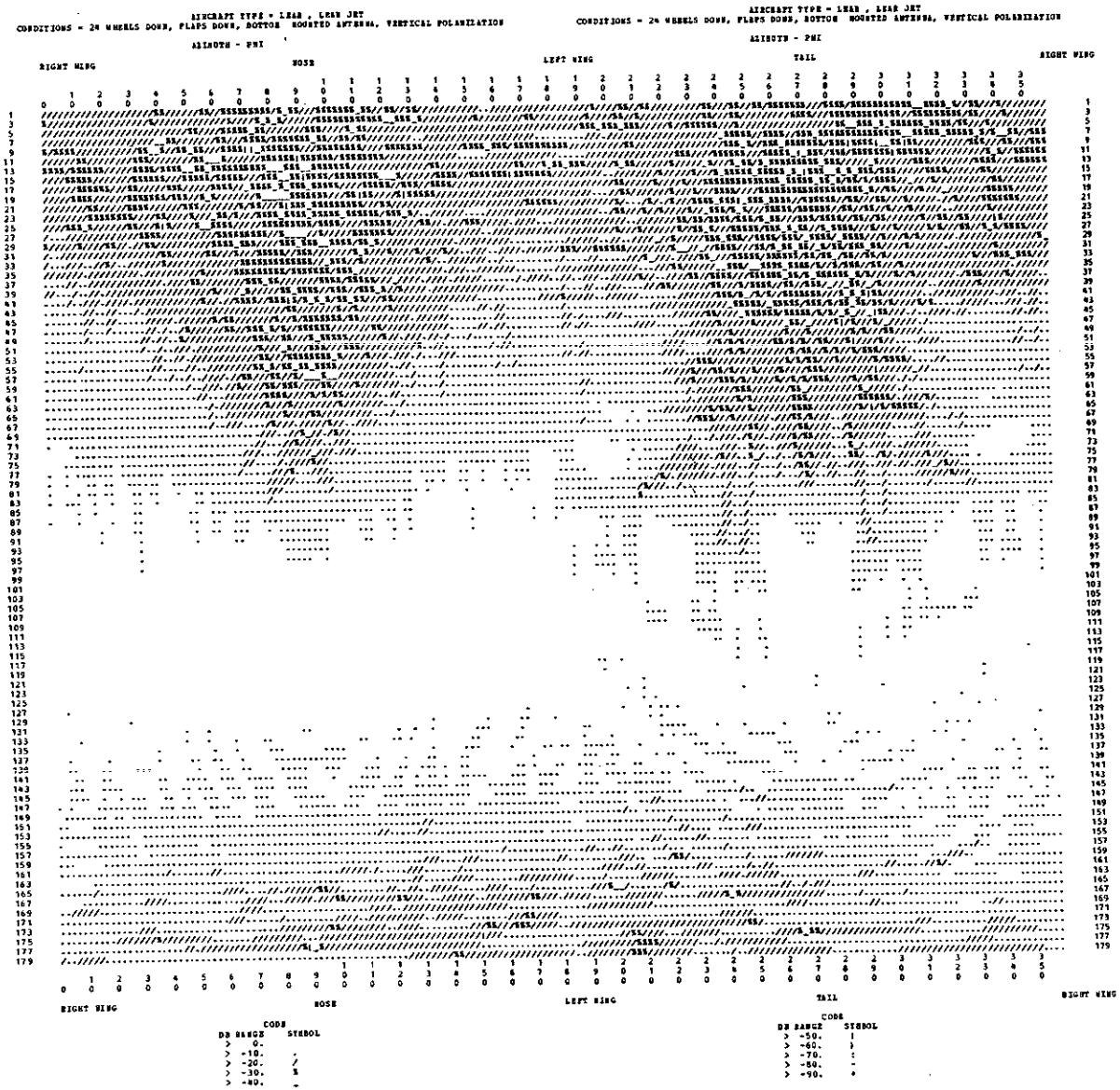

Fig. 7-14. Gates Lear jet; antenna position 4 (B); wheels down, flaps down.

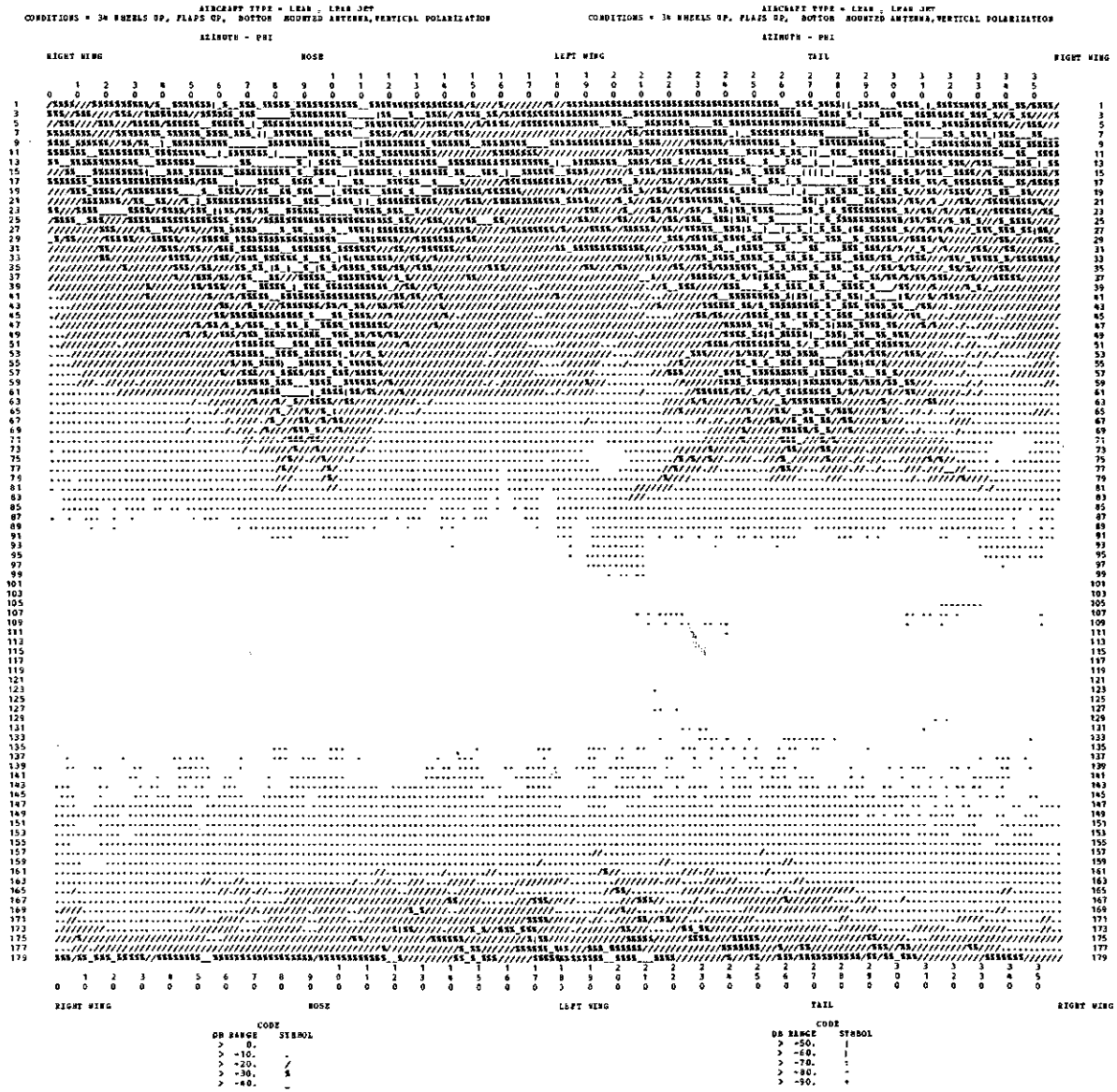

Fig. 7-15. Gates Lear jet; antenna position 4 (B); wheels up, flaps up.

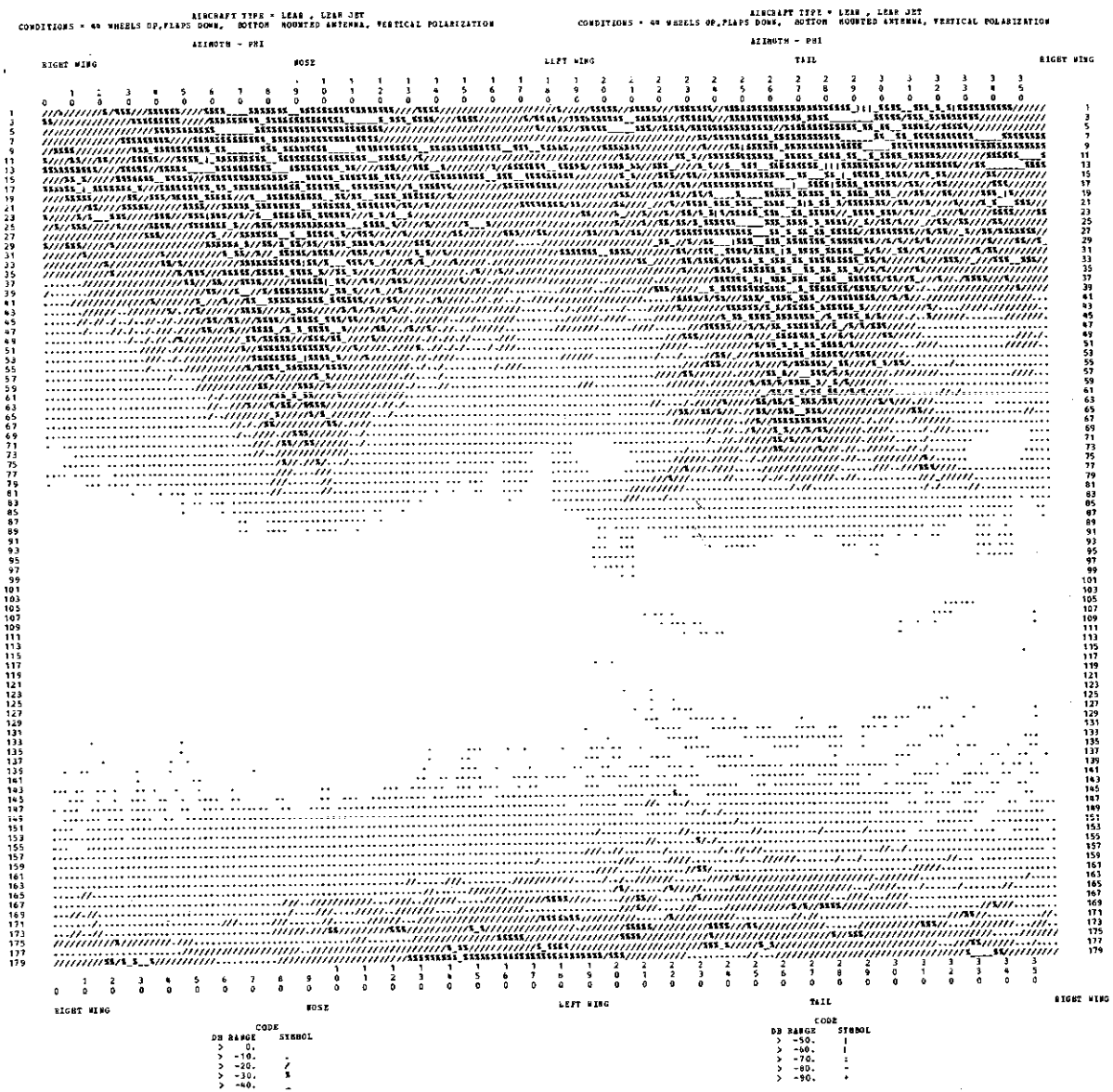

Fig. 7-16. Gates Lear jet; antenna position 4 (B); wheels up, flaps down.

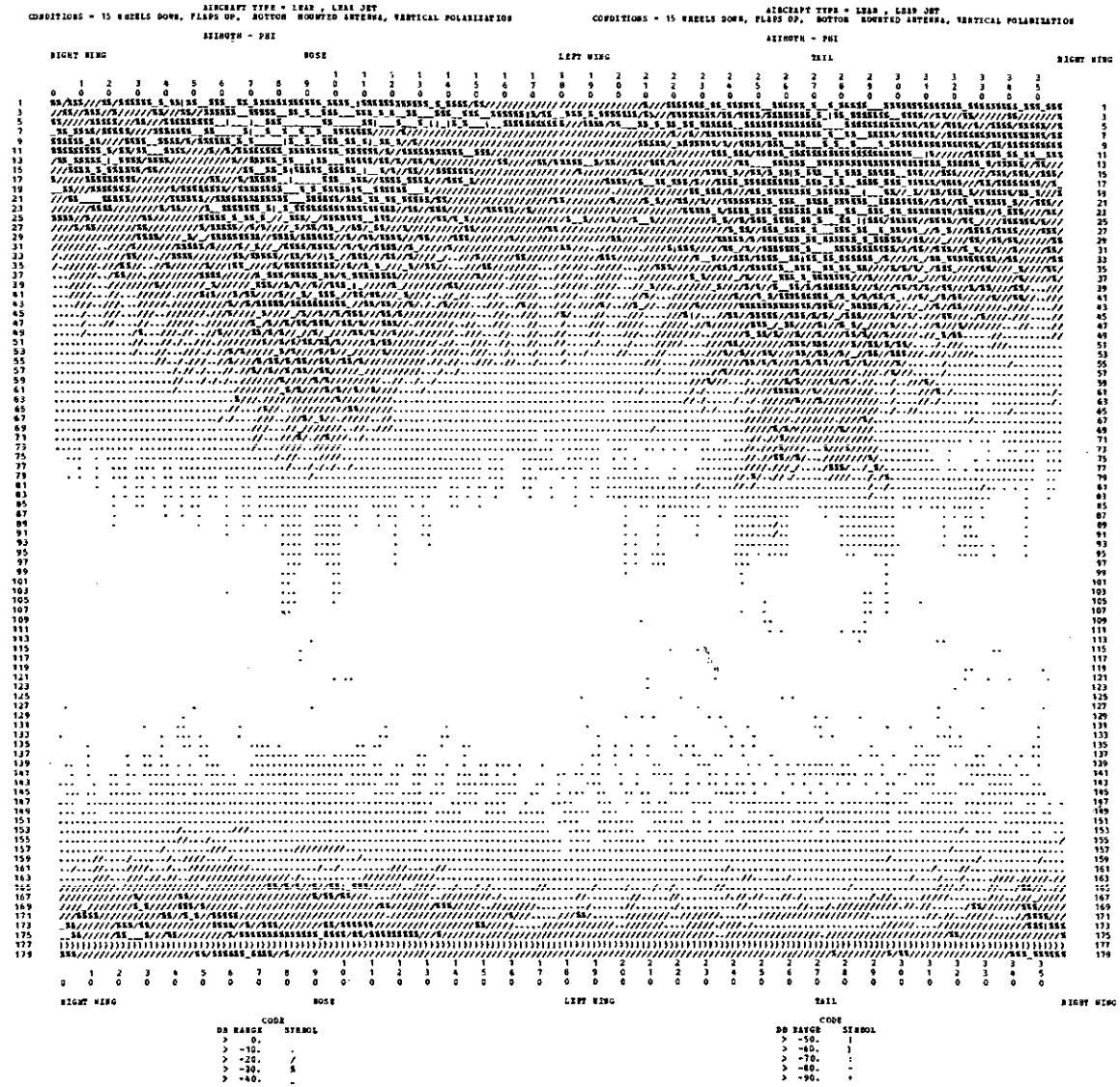

Fig. 7-17. Gates Lear jet; antenna position 5 (B); wheels down, flaps up.

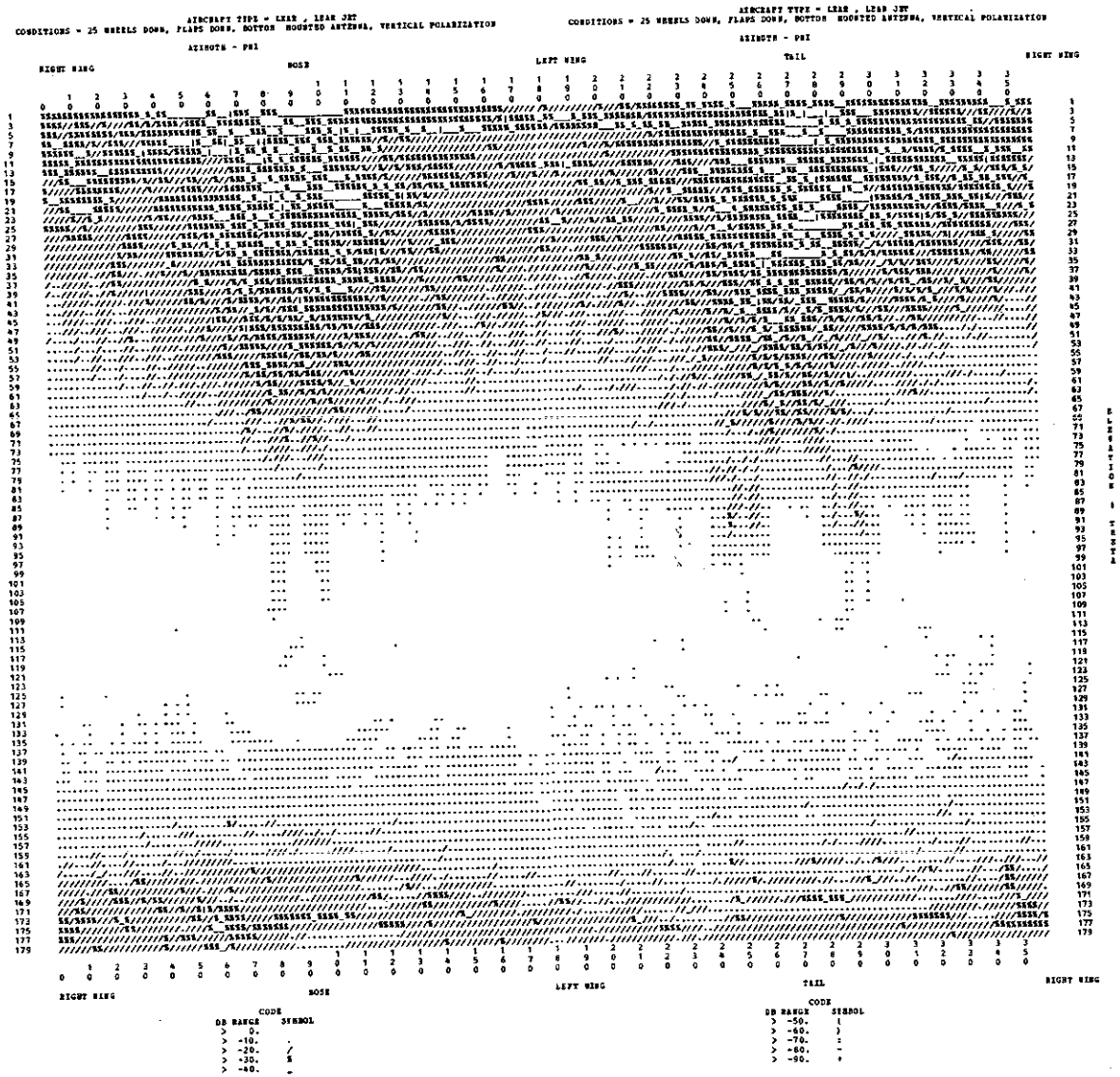

Fig. 7-18. Gates Lear jet; antenna position 5 (B); wheels down, flaps down.

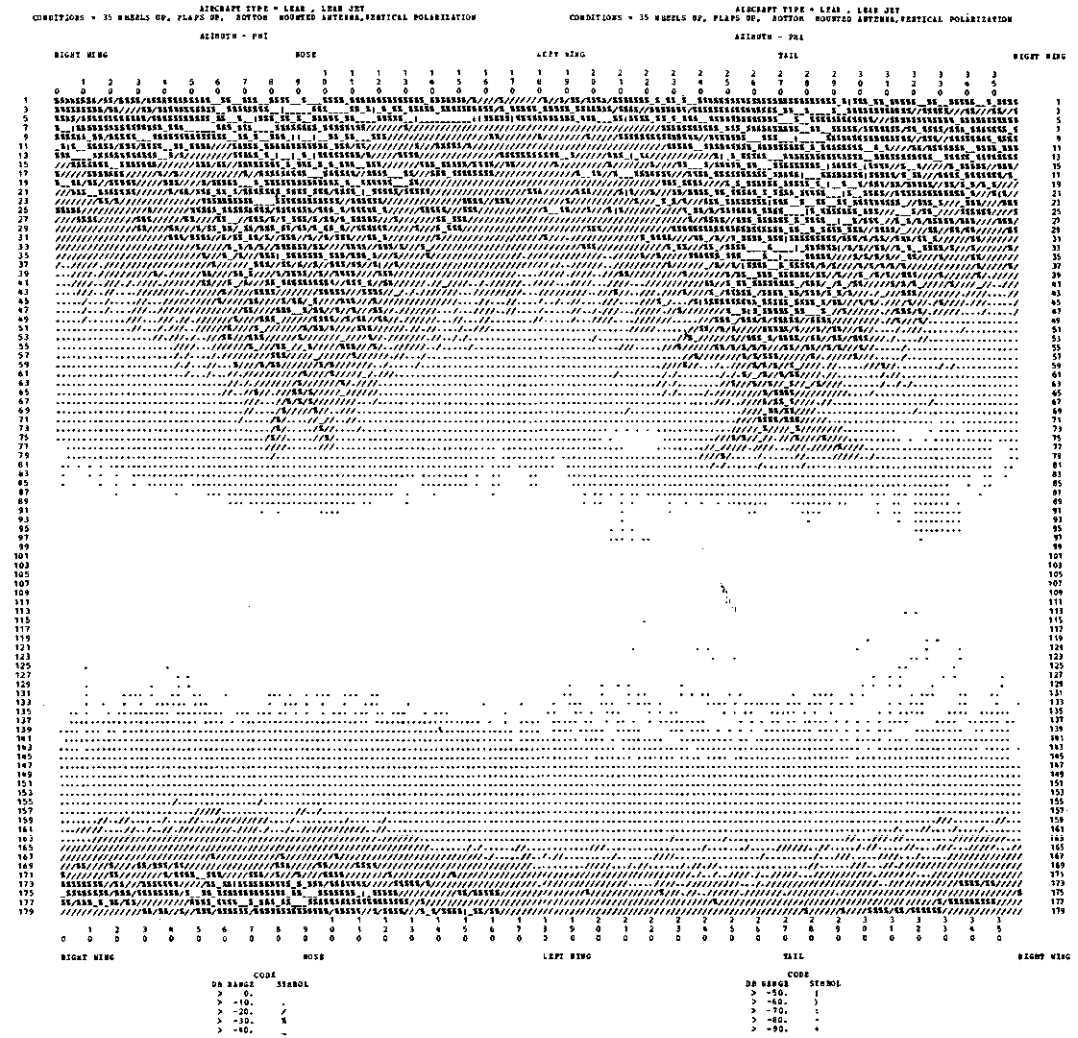

Fig. 7-19. Gates Lear jet; antenna position 5 (B); wheels up, flaps up.

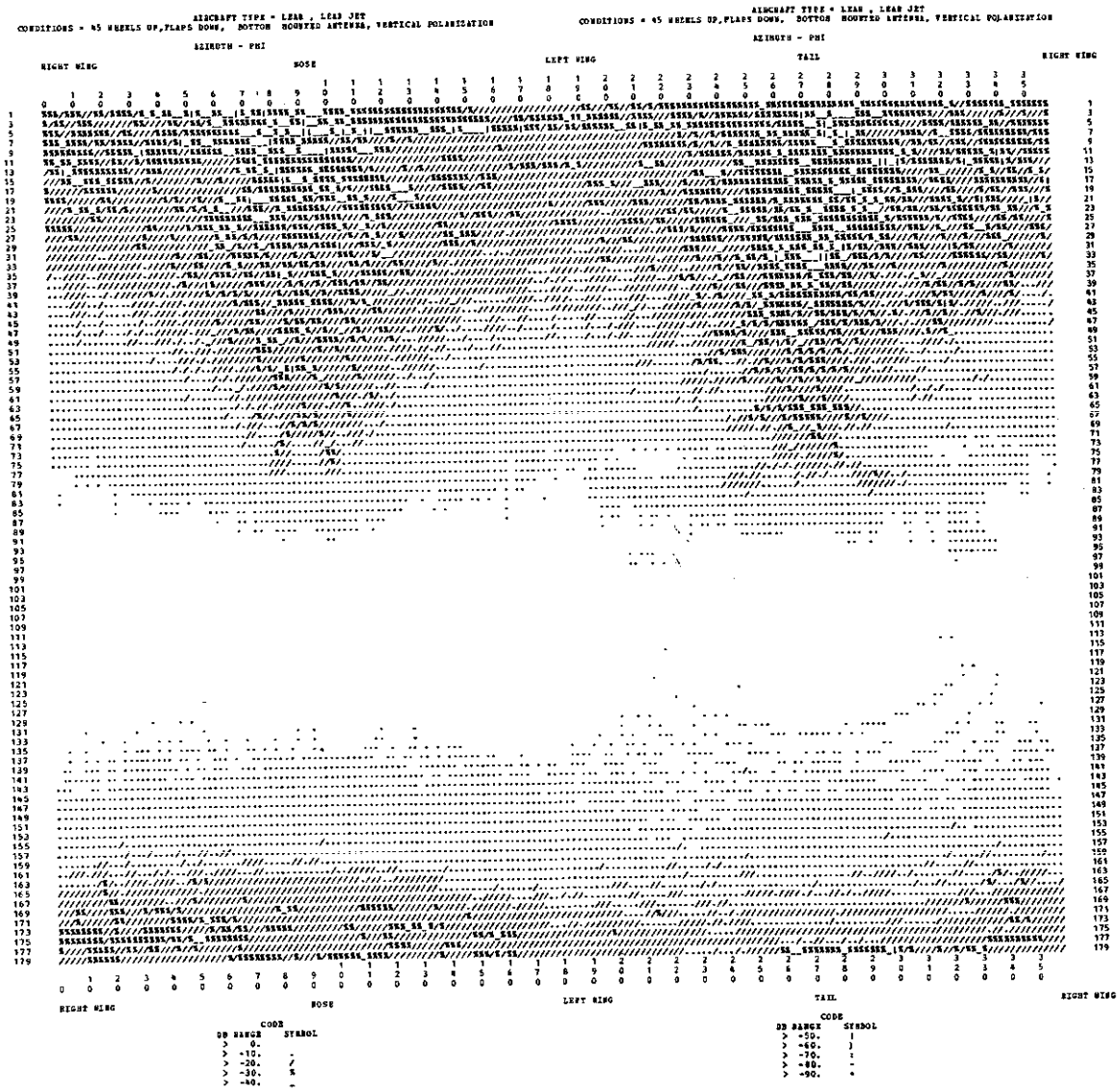

Fig. 7-20. Gates Lear jet; antenna position 5 (B); wheels up, flaps down.

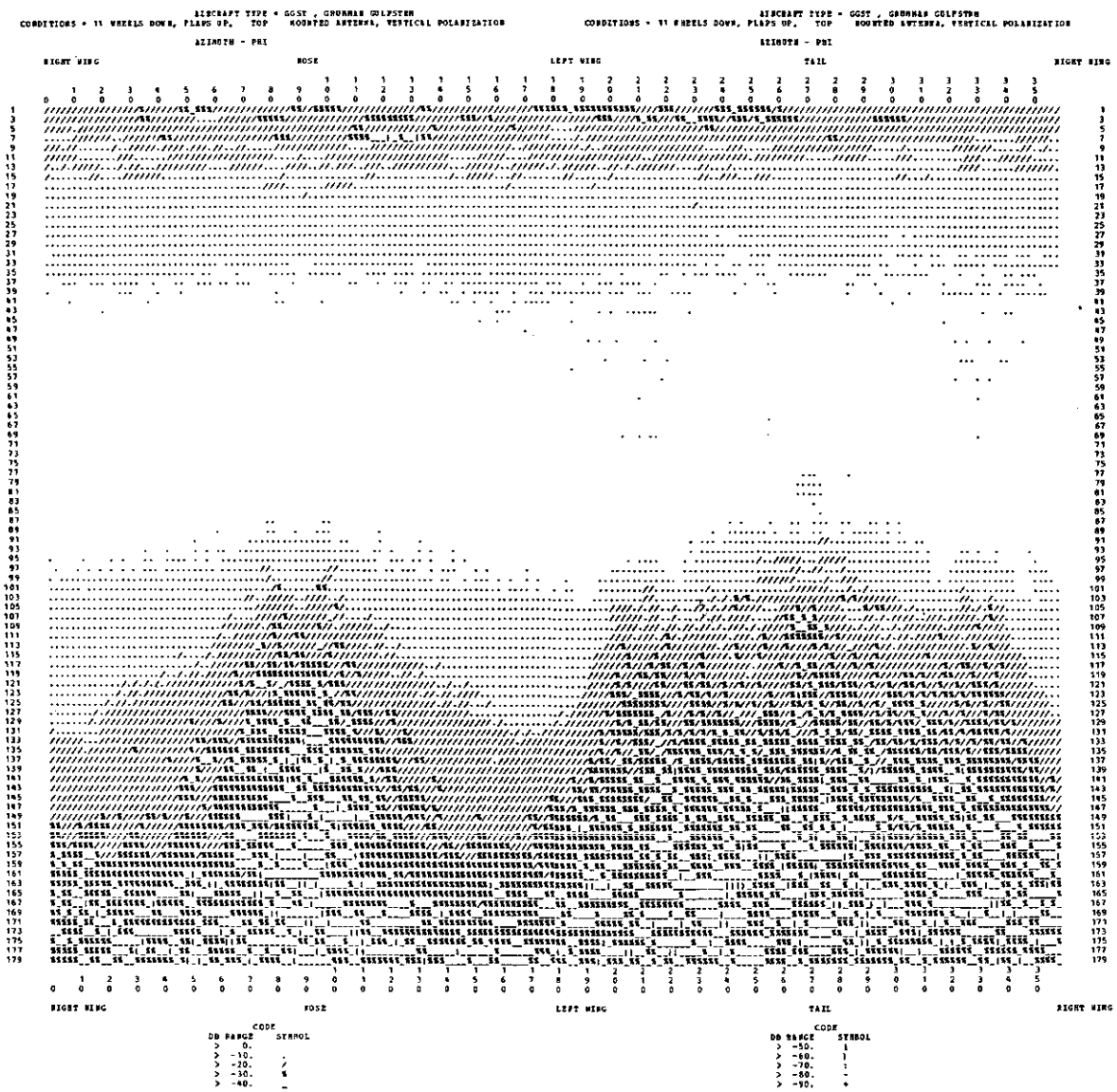

Fig. 8-1. Grumman Gulfstream; antenna position 1 (T); wheels down, flaps up.

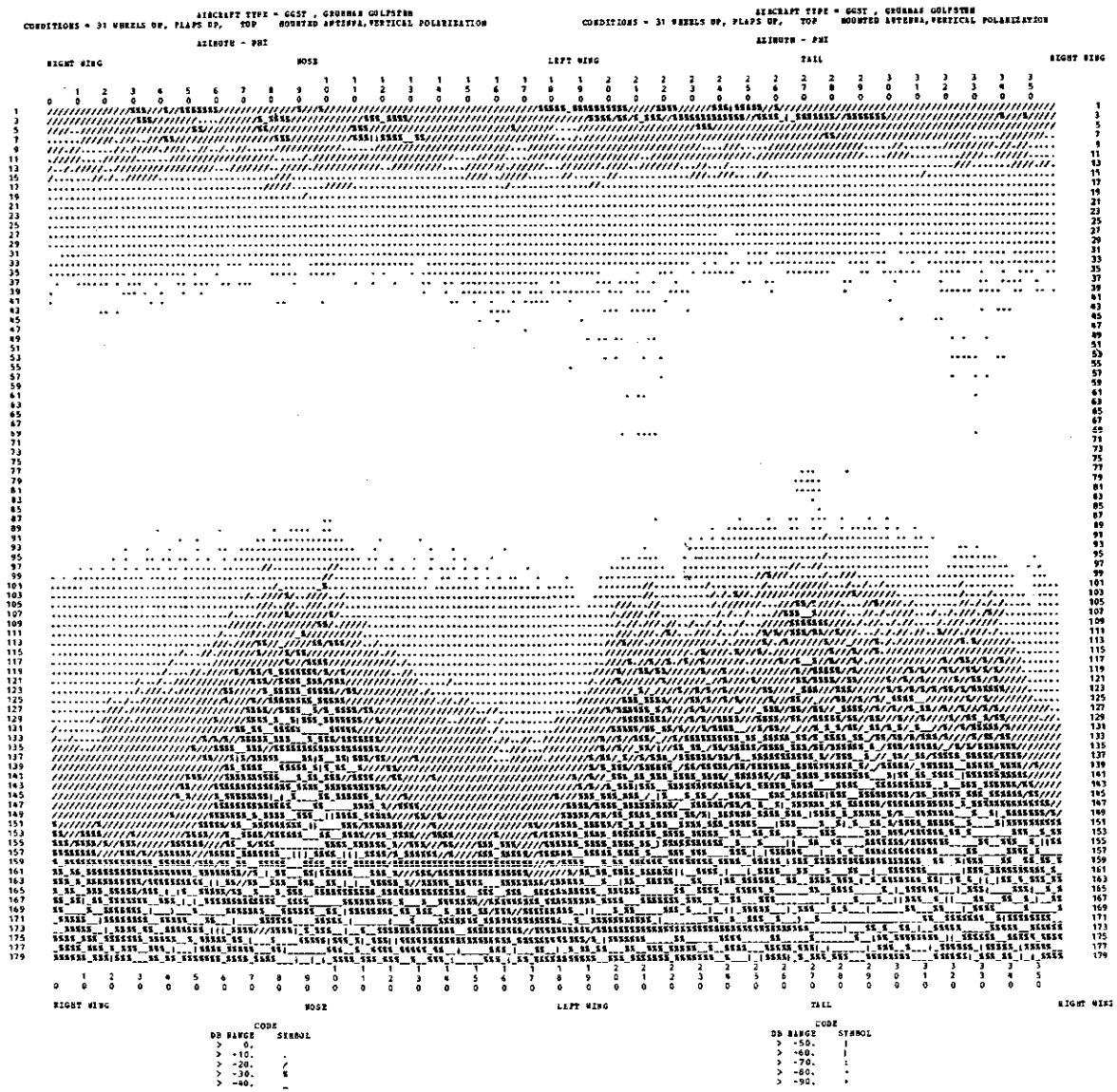

Fig. 8-2. Grumman Gulfstream; antenna position 1 (T); wheels up, flaps up.

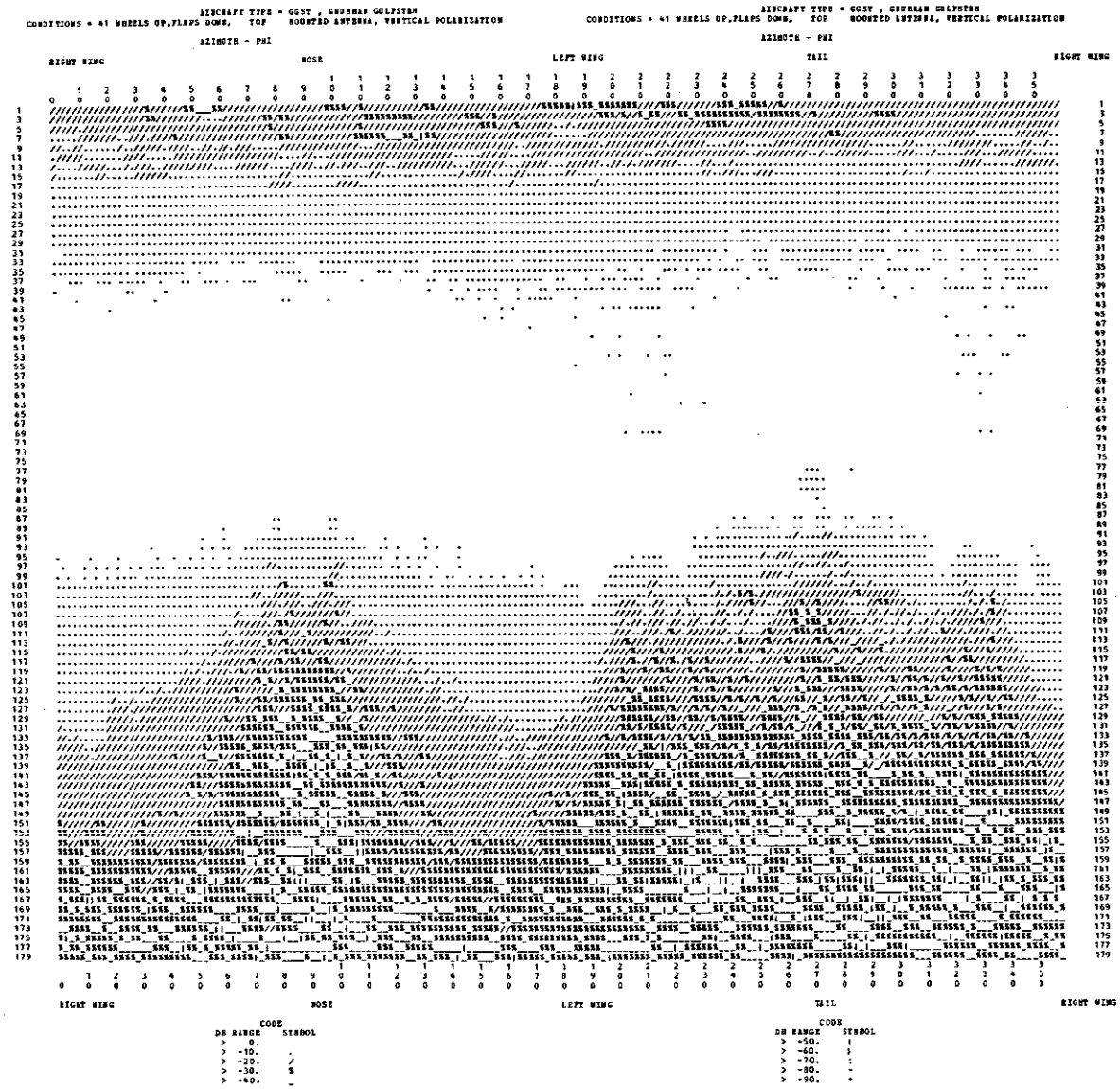

Fig. 8-3. Grumman Gulfstream; antenna position 1 (T); wheels up, flaps down.

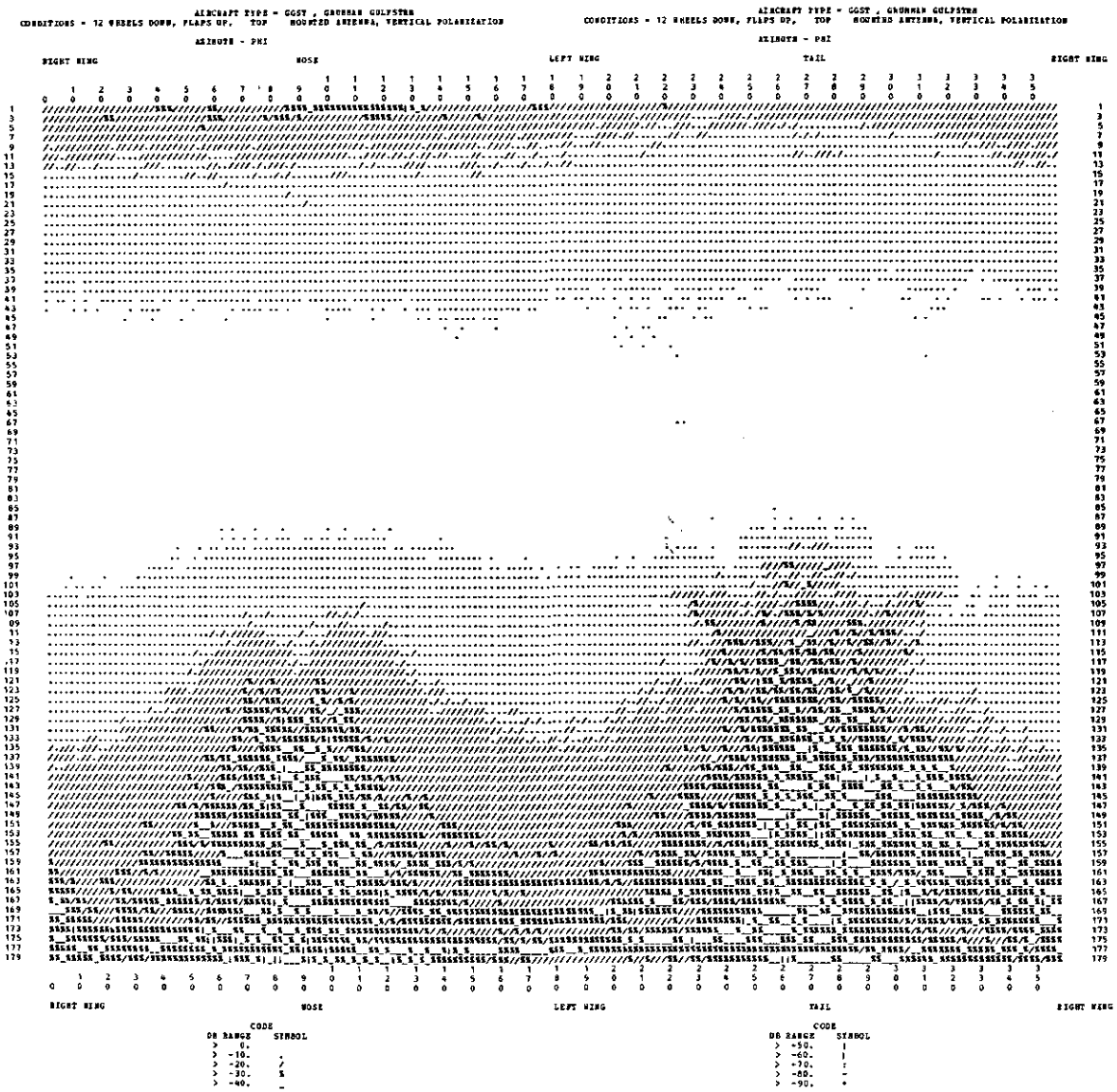

Fig. 8-4. Grumman Gulfstream; antenna position 2 (T); wheels down, flaps up.

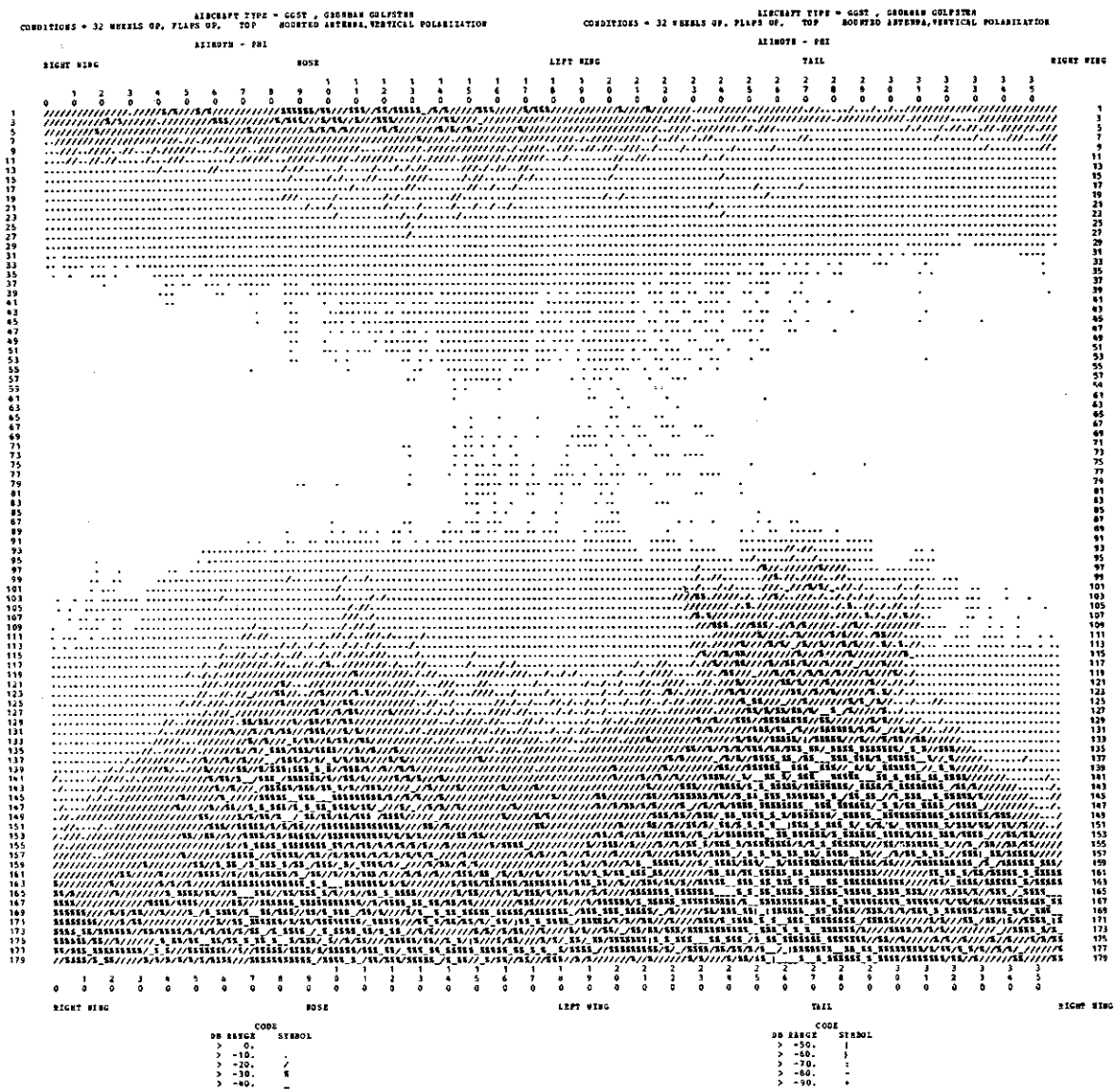

Fig. 8-5. Grumman Gulfstream; antenna position 2 (T); wheels up, flaps up.

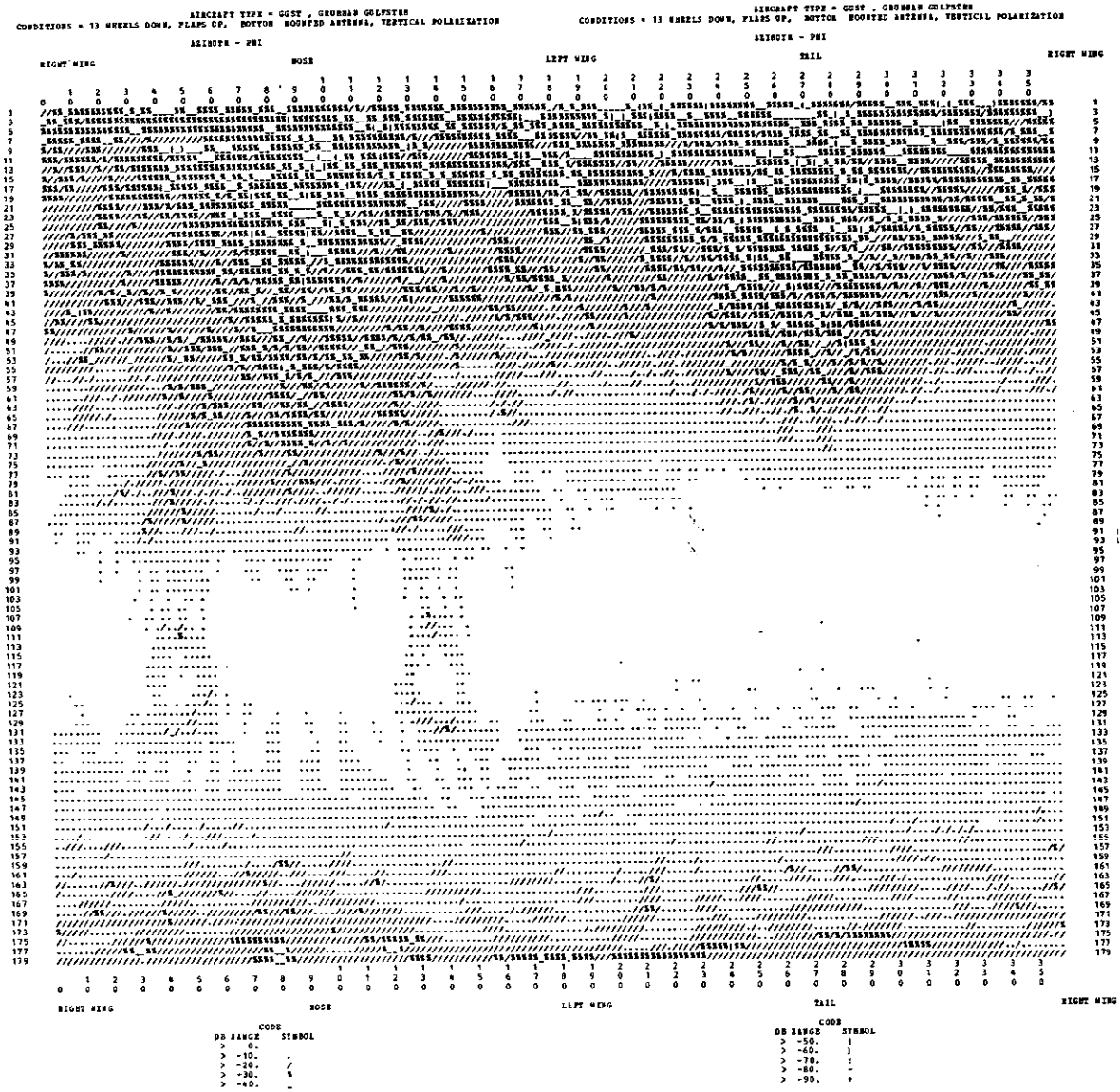

Fig. 8-6. Grumman Gulfstream; antenna position 3 (B); wheels down, flaps up.

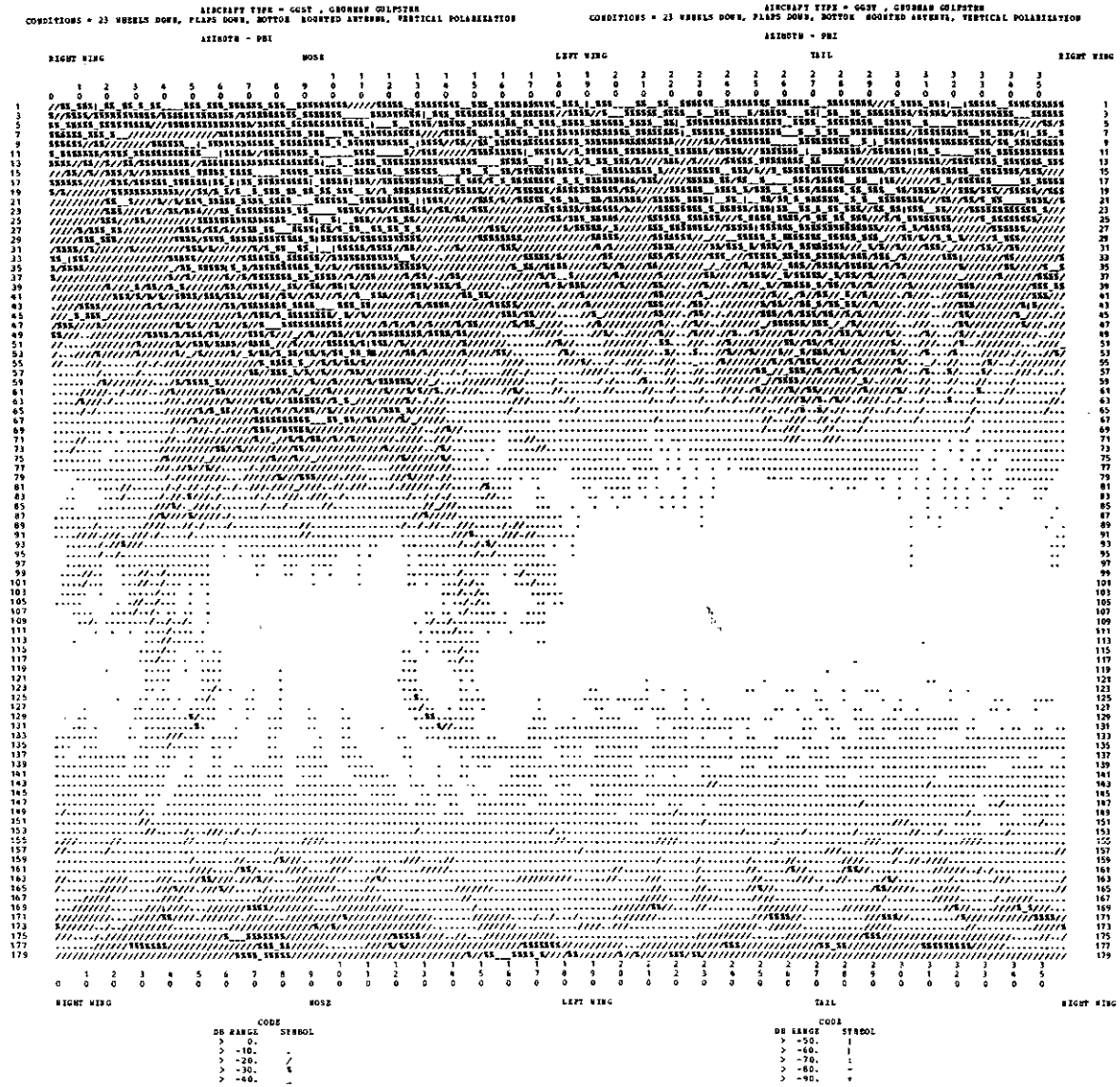

Fig. 8-7. Grumman Gulfstream; antenna position 3 (B); wheels down, flaps down.

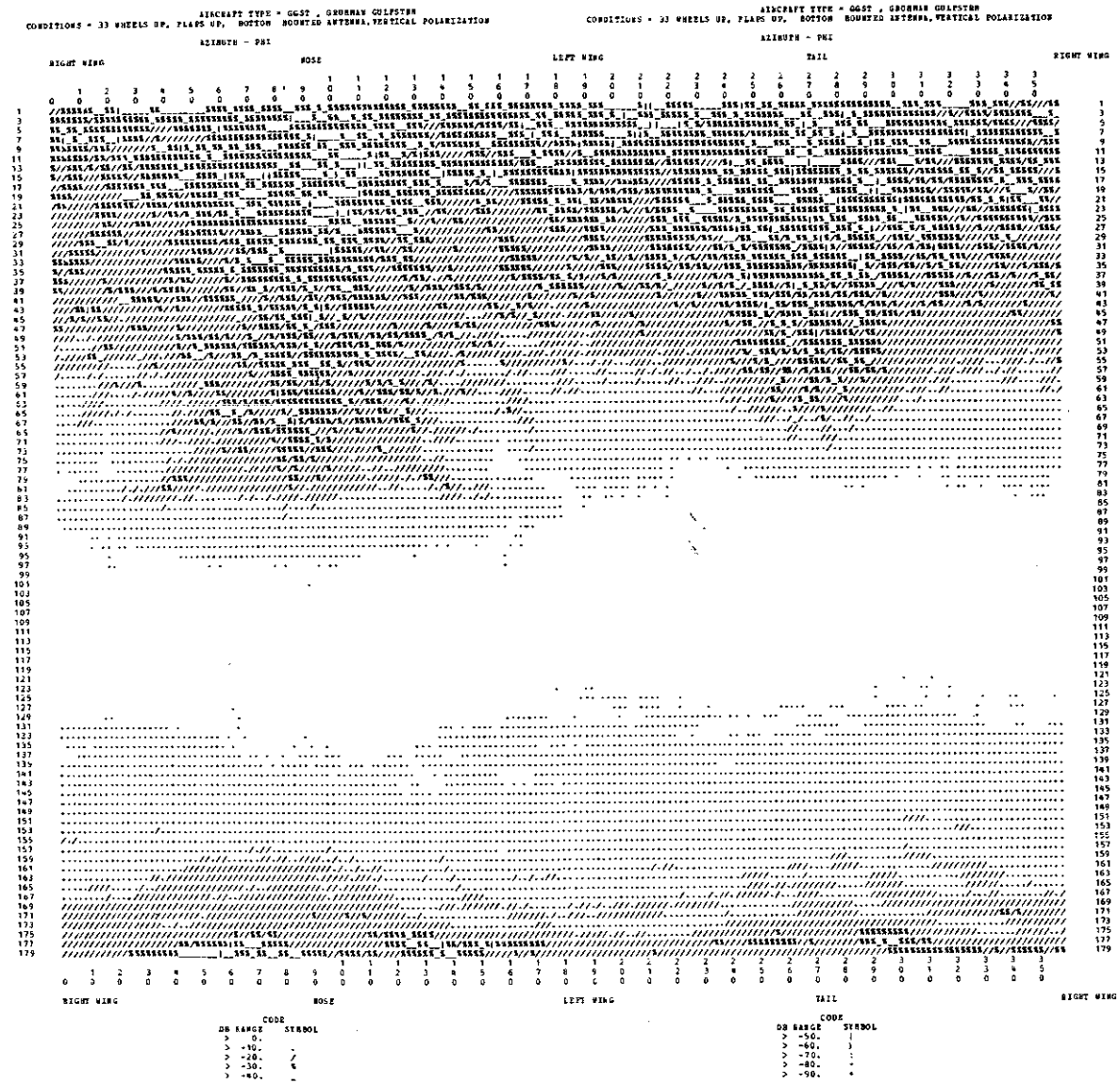

Fig. 8-8. Grumman Gulfstream; antenna position 3 (B); wheels up, flaps up.

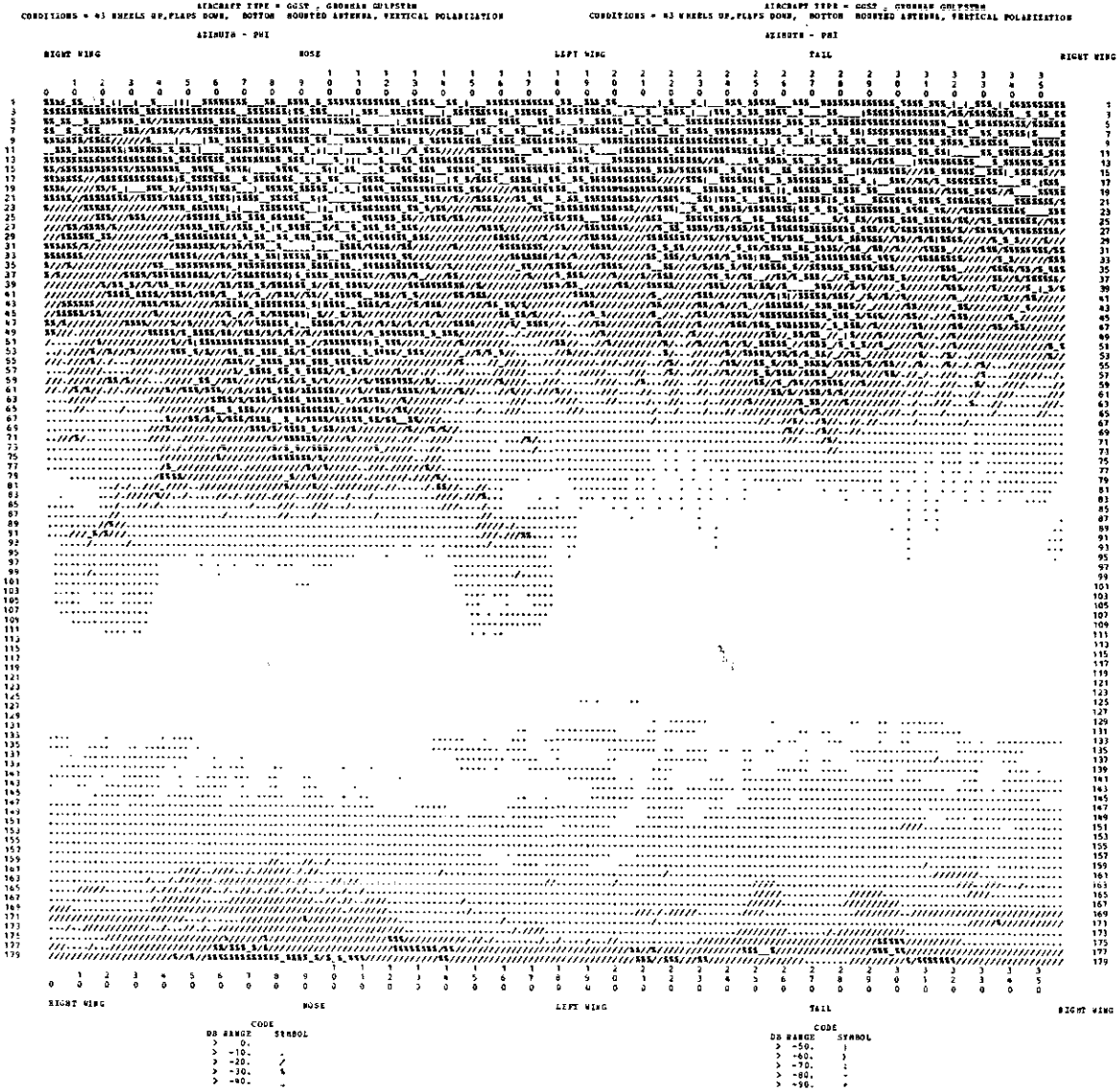

Fig. 8-9. Grumman Gulfstream; antenna position 3 (B); wheels up, flaps down.

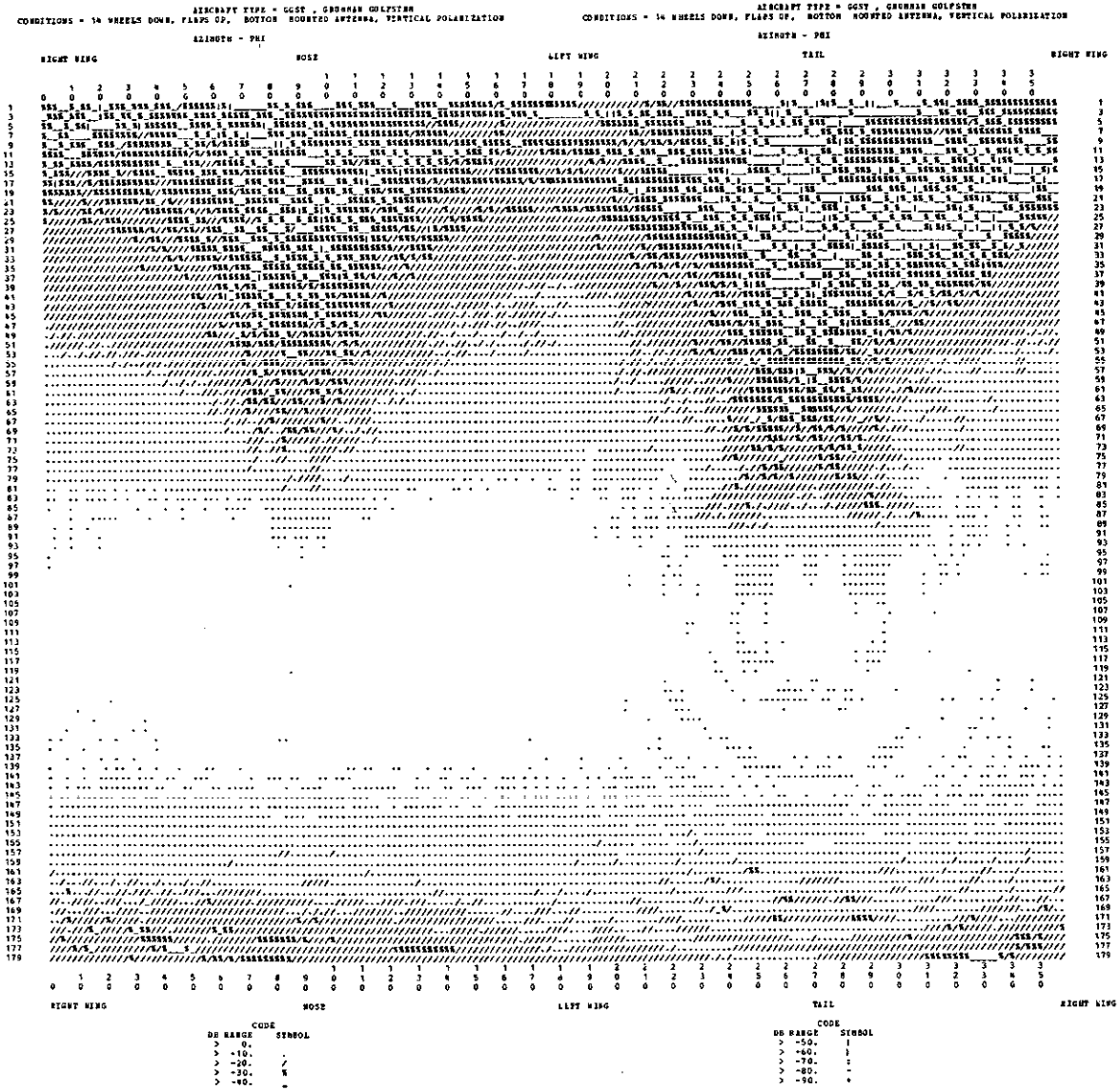

Fig. 8-10. Grumman Gulfstream; antenna position 4 (B); wheels down, flaps up.

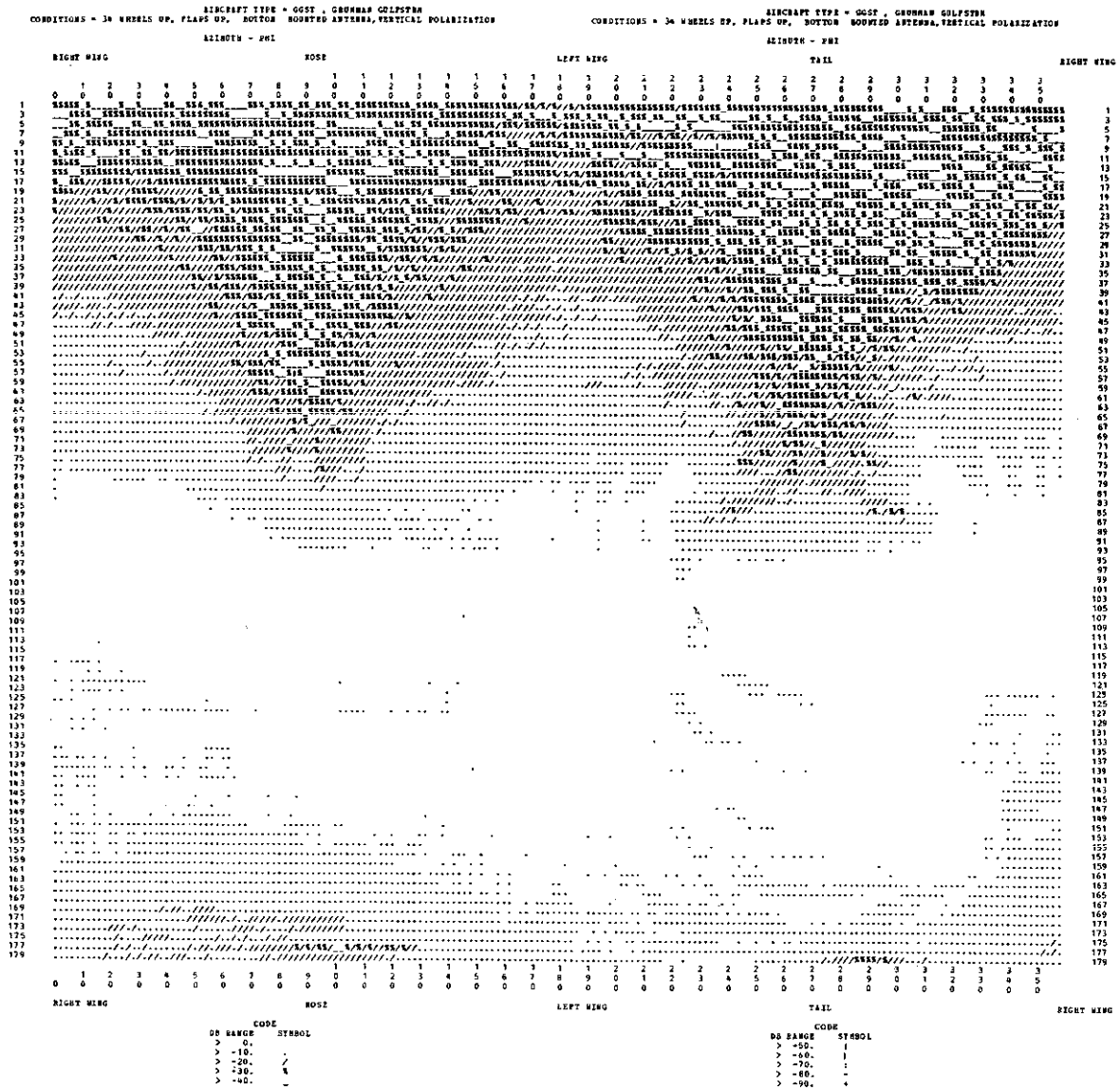

Fig. 8-11. Grumman Gulfstream; antenna position 4 (B); wheels up, flaps up.

AIR CARRIER*

1. Boeing 707
2. Boeing 727
3. Boeing 737
4. Boeing 747

*All positions measured with flaps up.

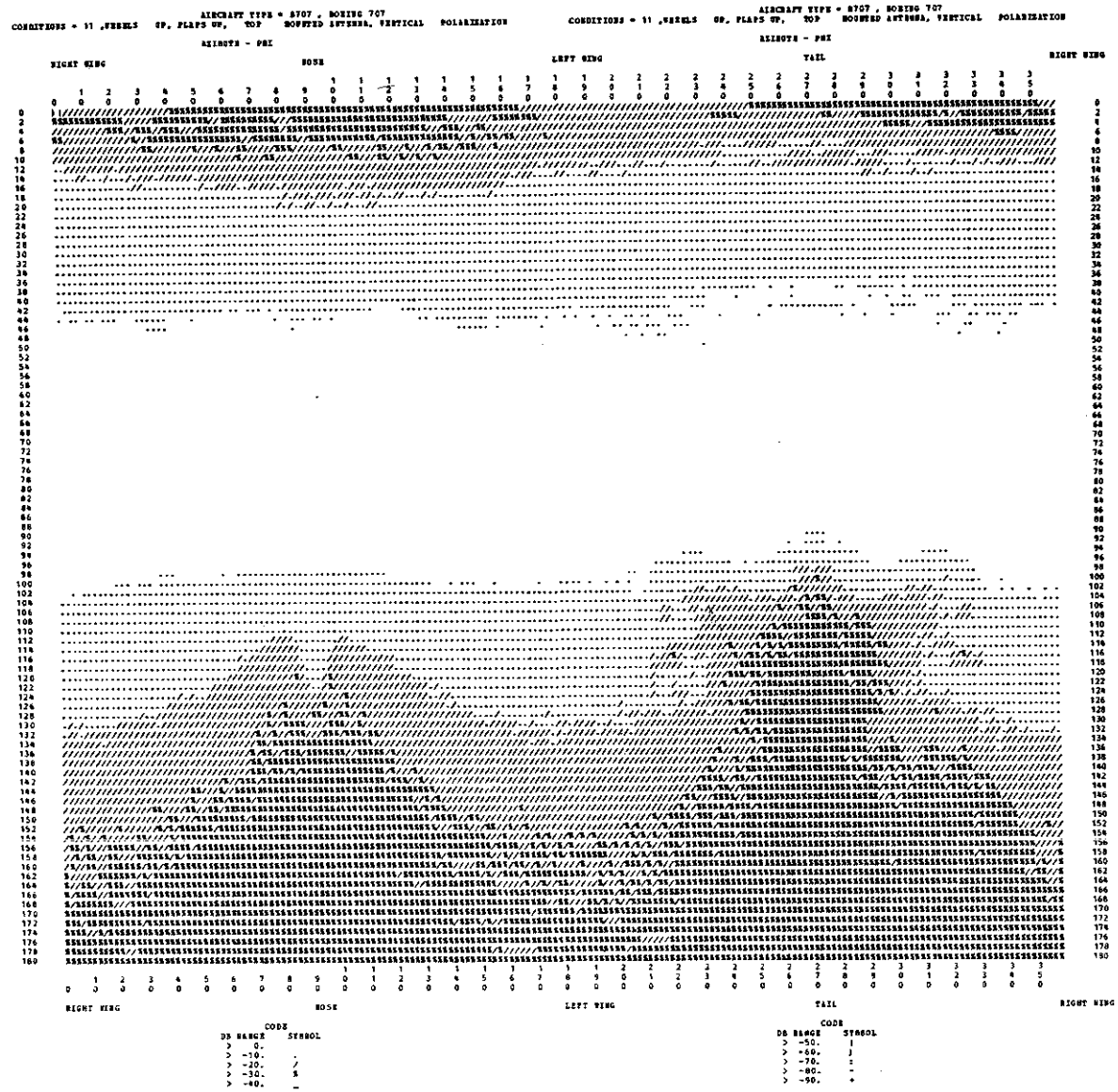

Fig. 9-1. Boeing 707; antenna position 1 (T); wheels up, vertical polarization.

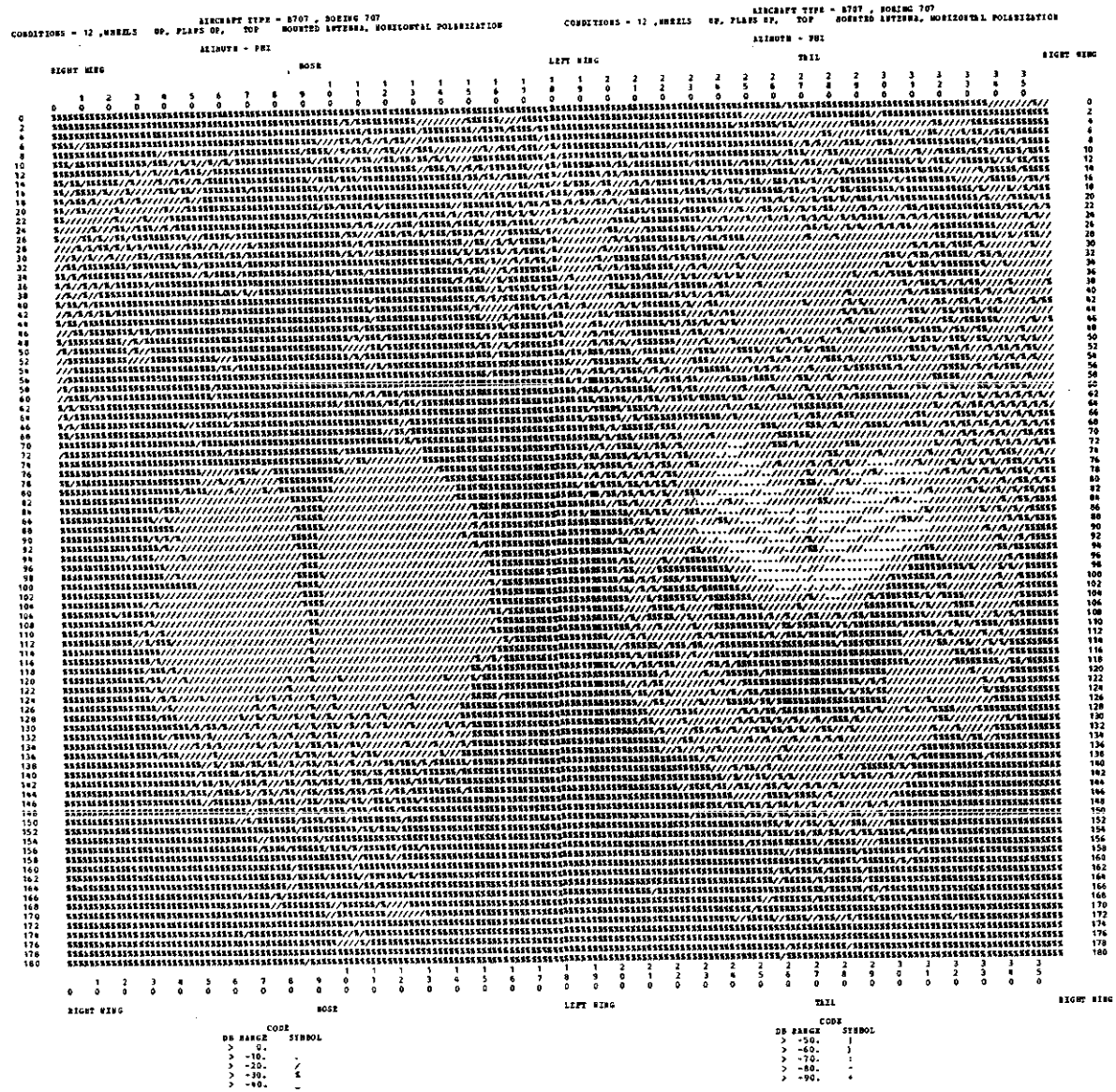

Fig. 9-2. Boeing 707; antenna position 1 (T); wheels up; horizontal polarization.

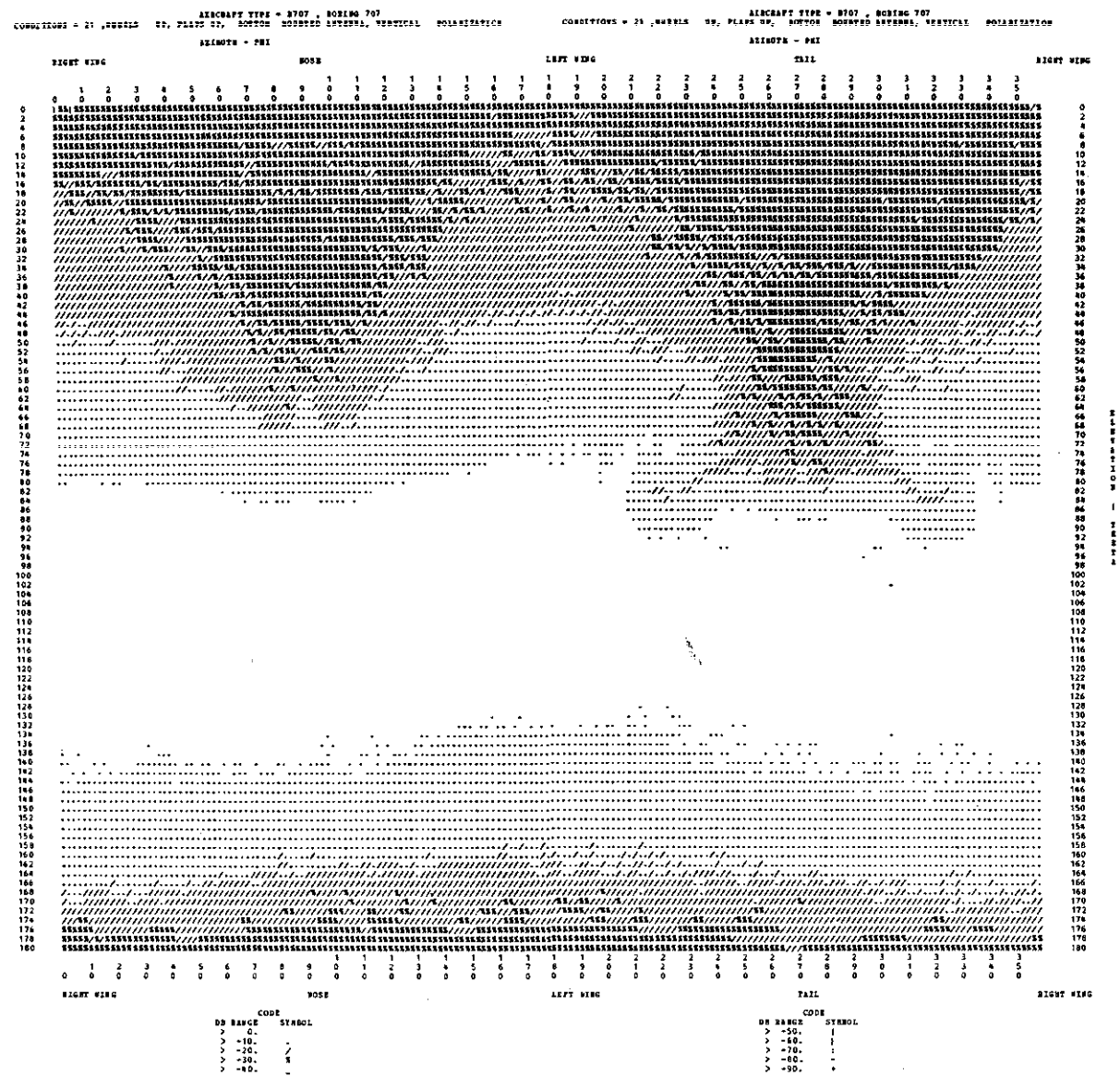

Fig. 9-3. Boeing 707; antenna position 2 (B); wheels up; vertical polarization.

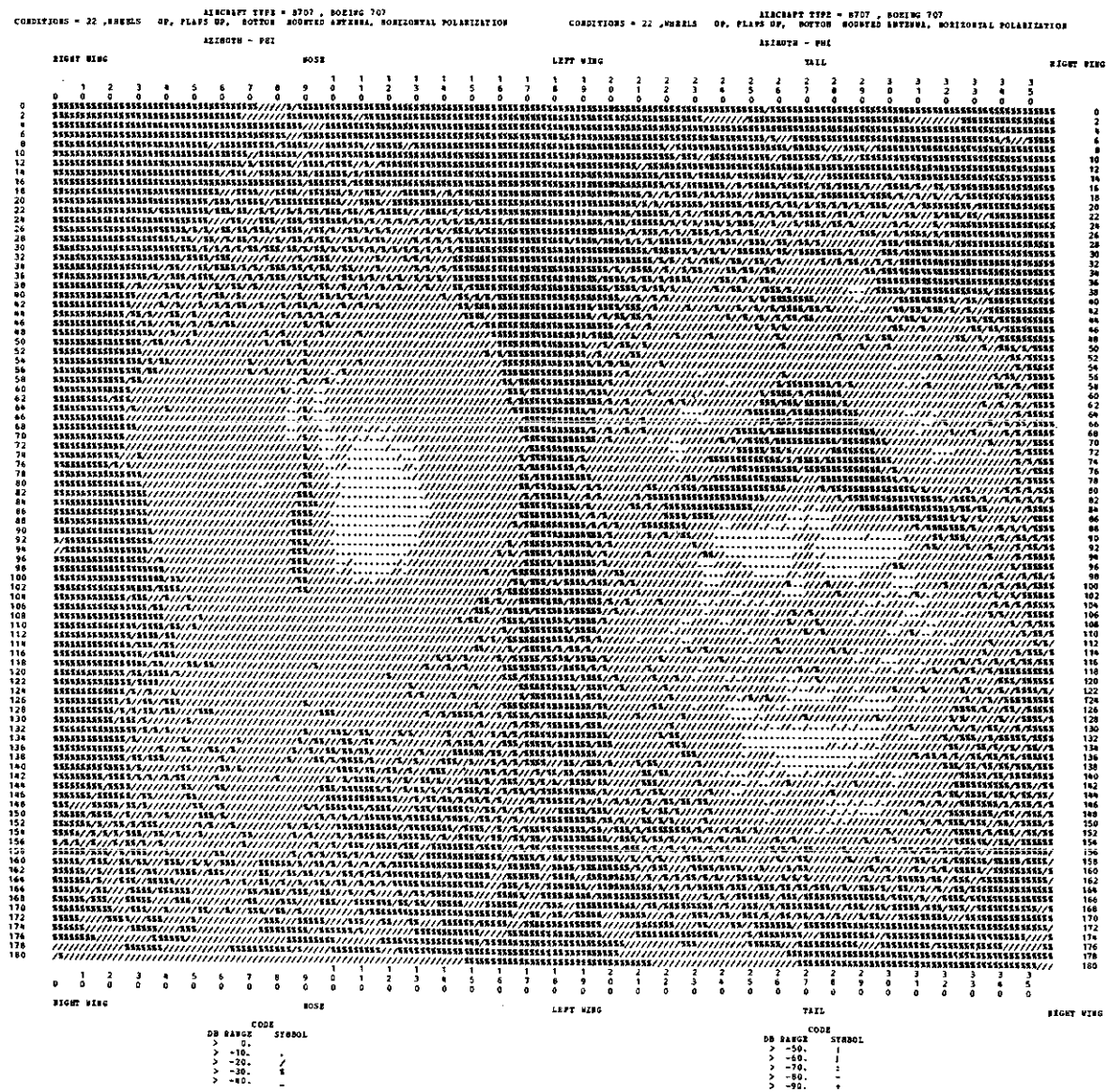

Fig. 9-4. Boeing 707; antenna position 2 (B); wheels up; horizontal polarization.

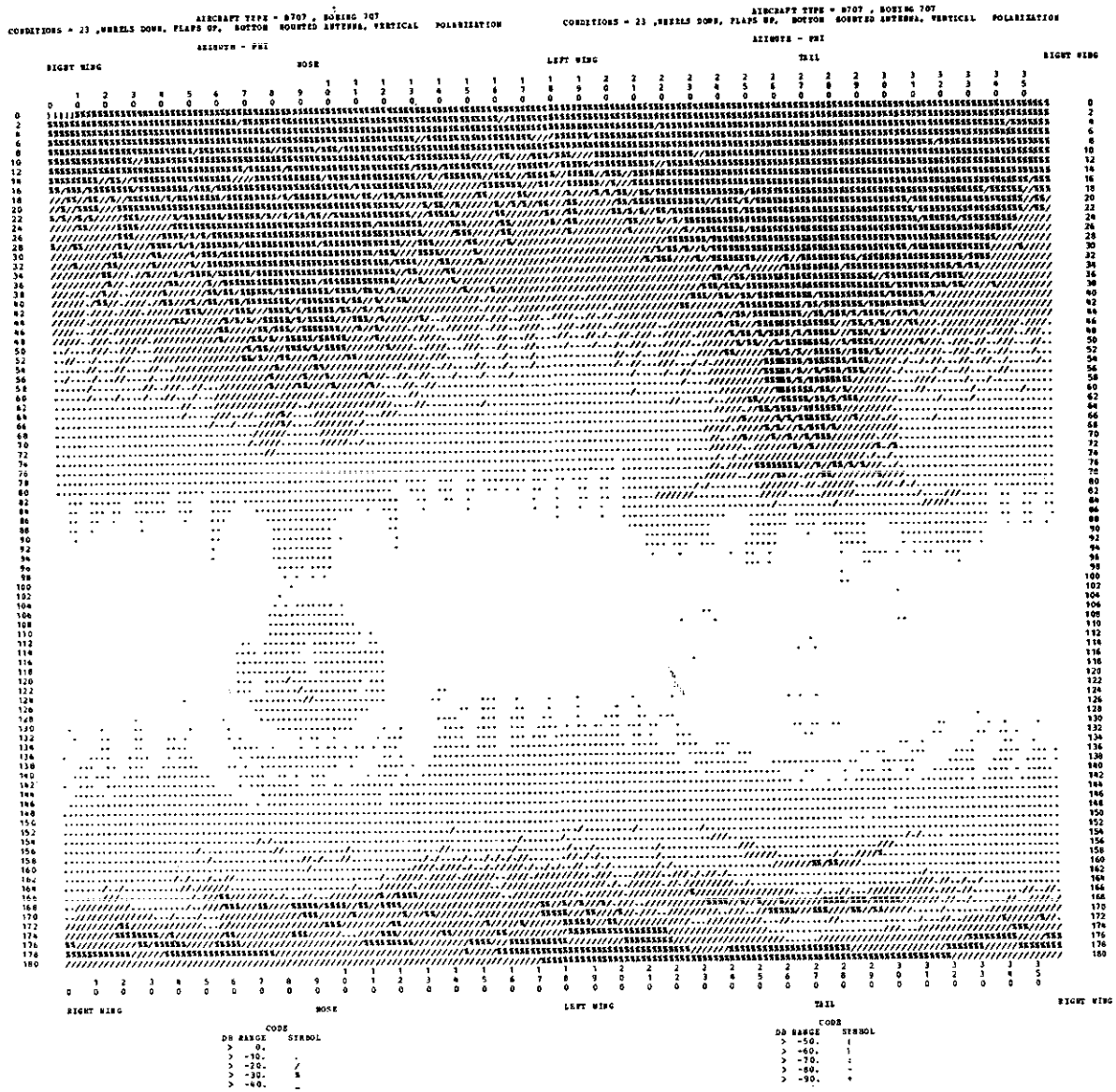

Fig. 9-5. Boeing 707; antenna position 2 (B); wheels down; vertical polarization.

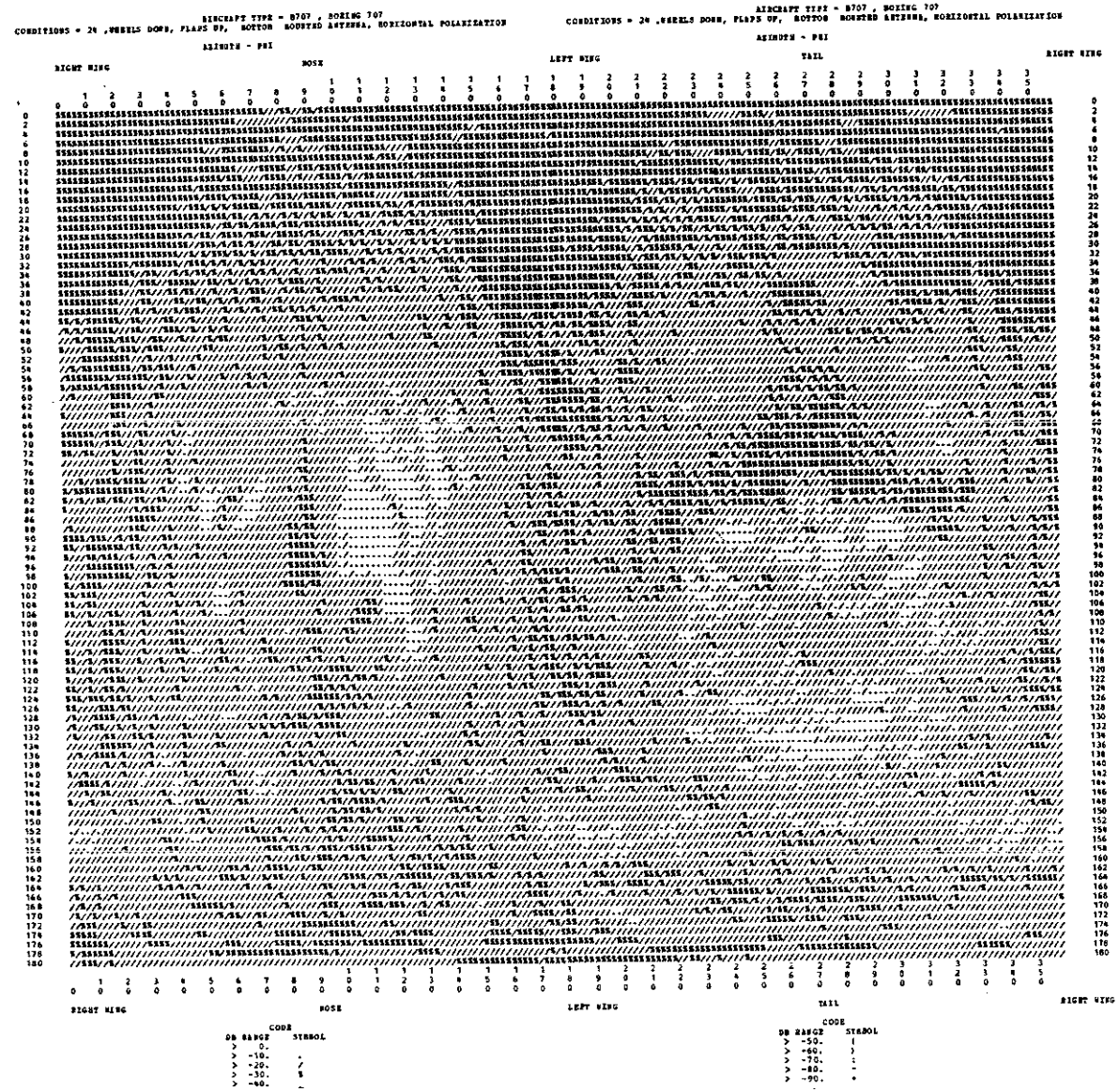

Fig. 9-6. Boeing 707; antenna position 2 (B); wheels down; horizontal polarization.

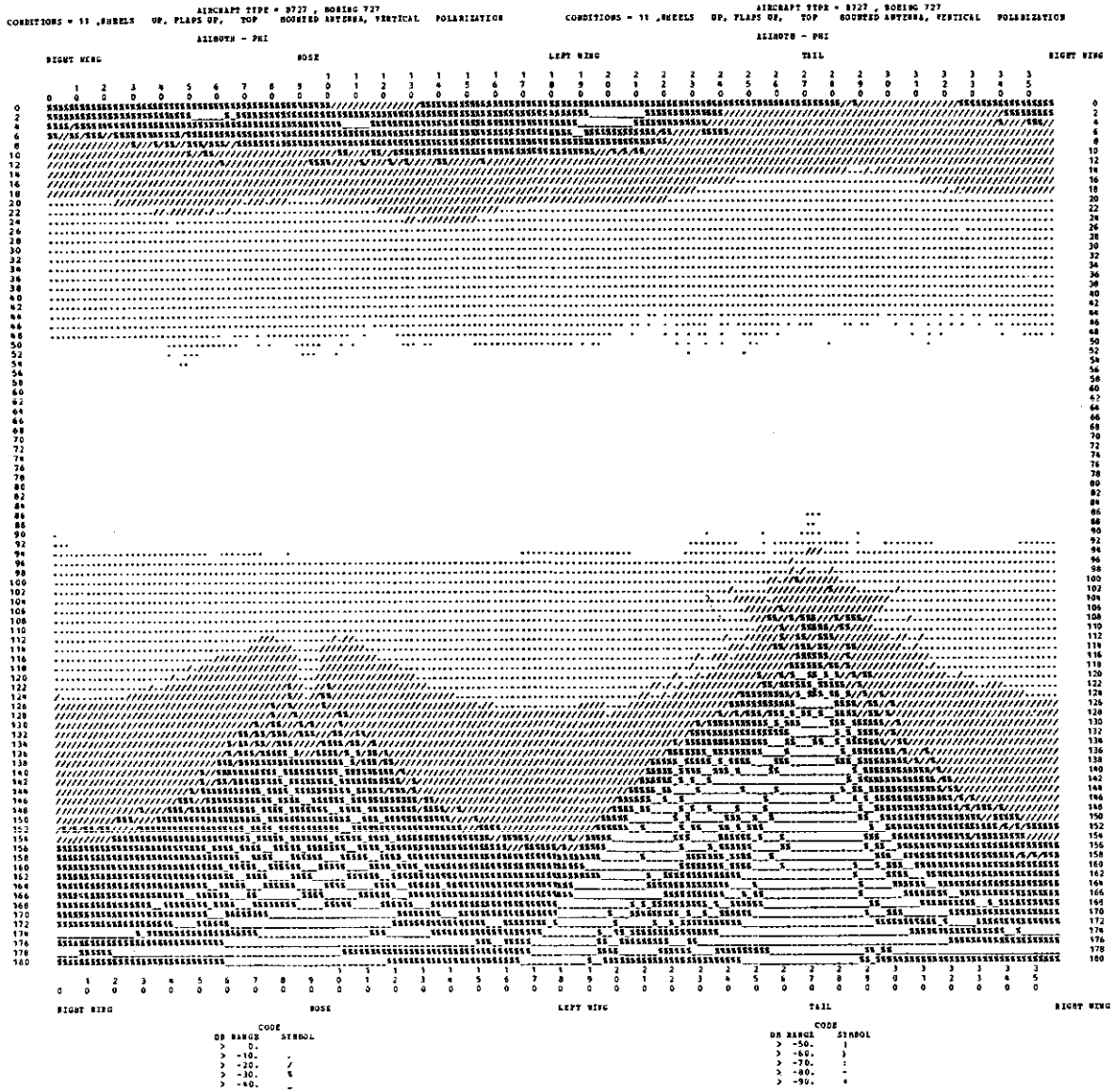

Fig. 10-1. Antenna position 1 (T); wheels up; vertical polarization.

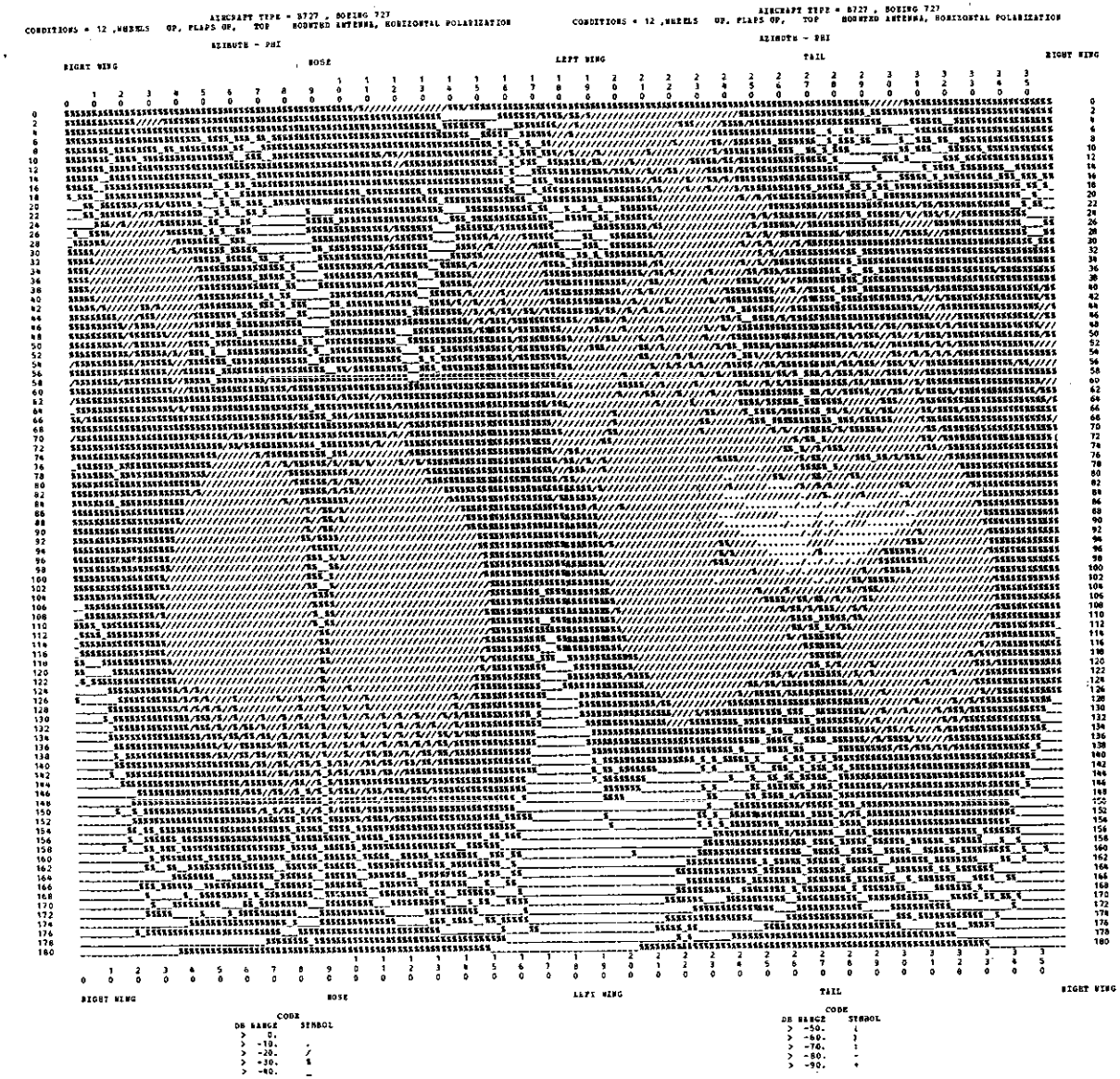

Fig. 10-2. Boeing 727; antenna position 1 (T); wheels up; horizontal polarization.

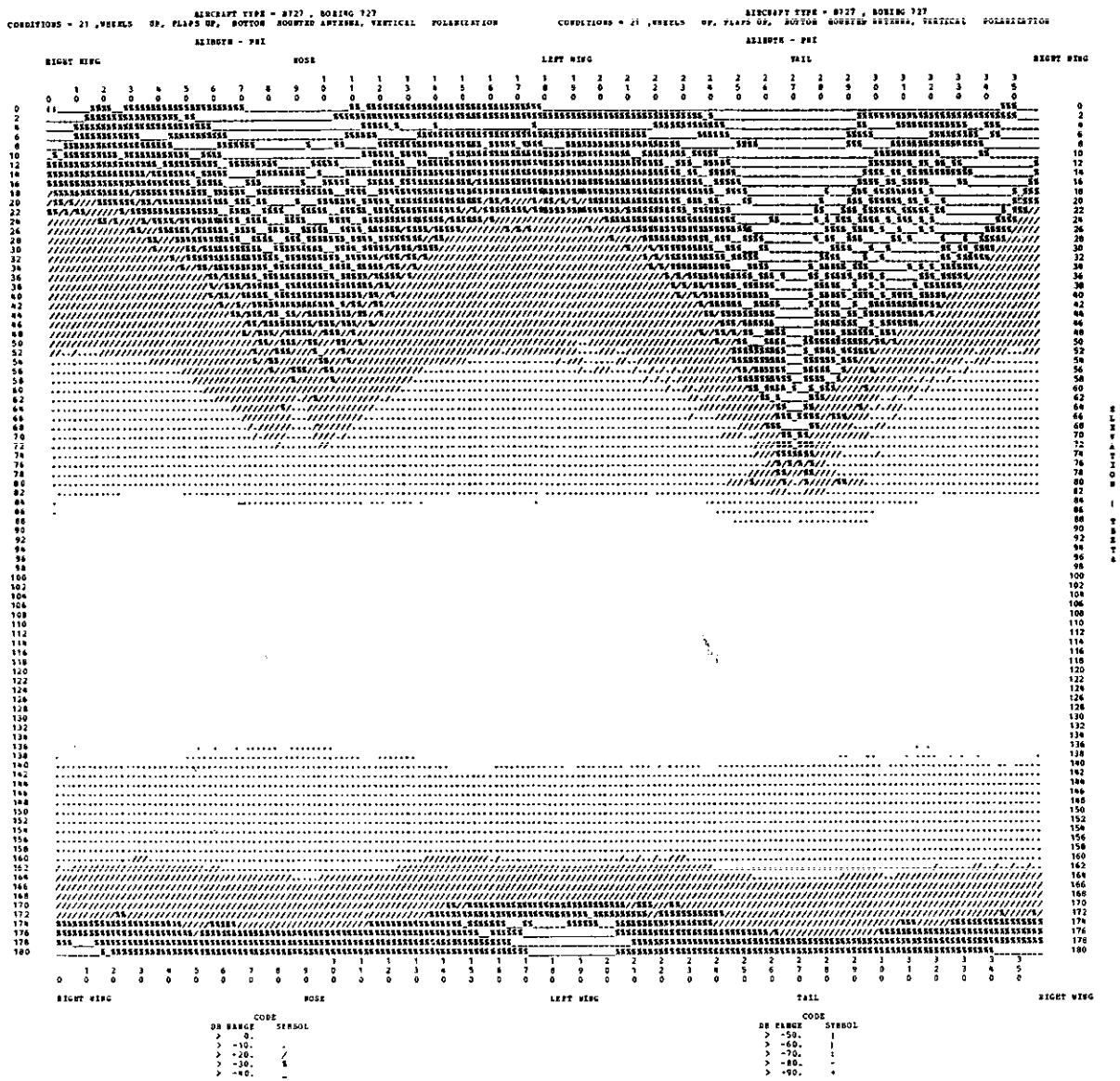

Fig. 10-3. Boeing 727; antenna position 2 (B); wheels up; vertical polarization.

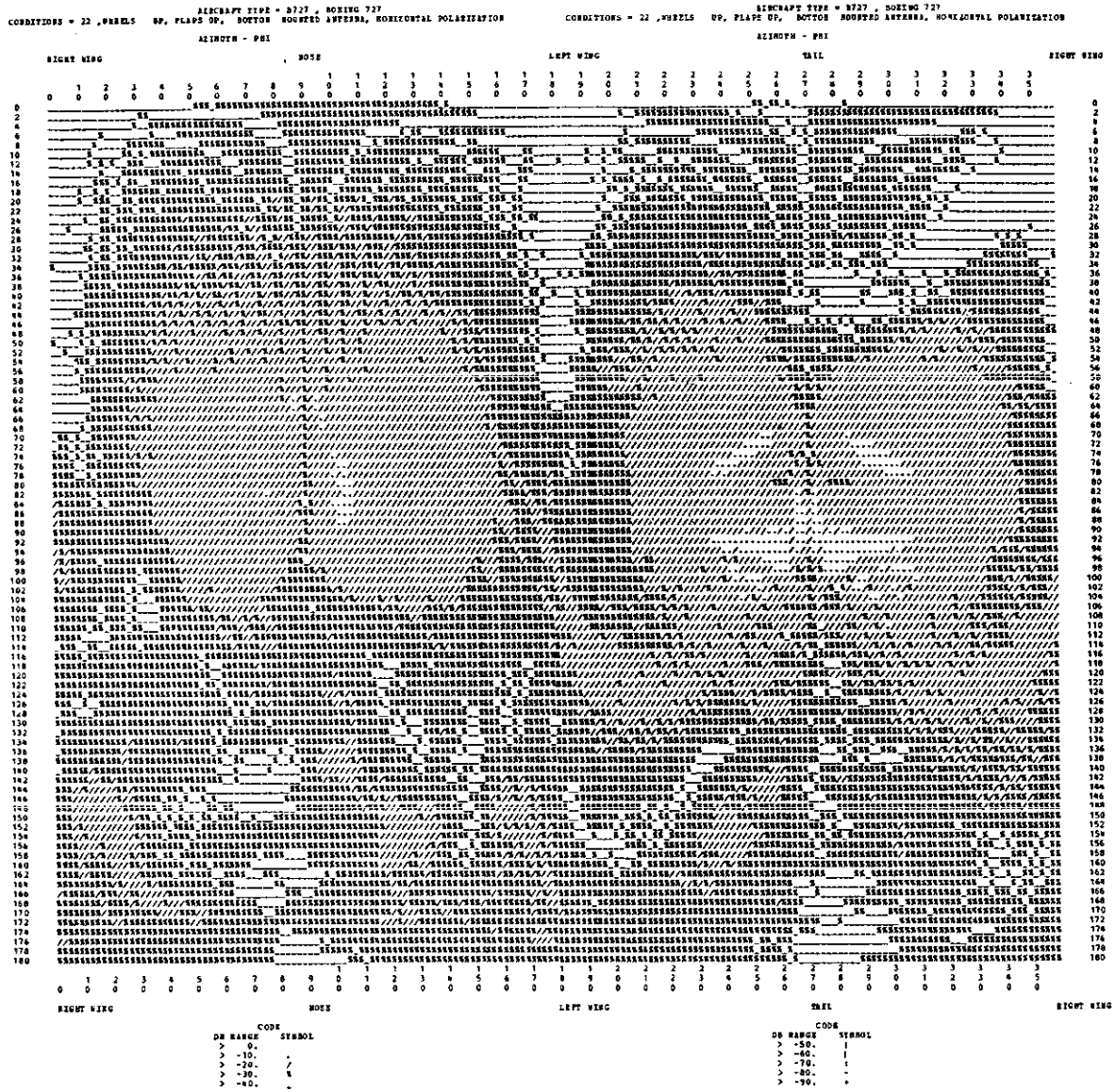

Fig. 10-4. Boeing 727; antenna position 2 (B); wheels up; horizontal polarization.

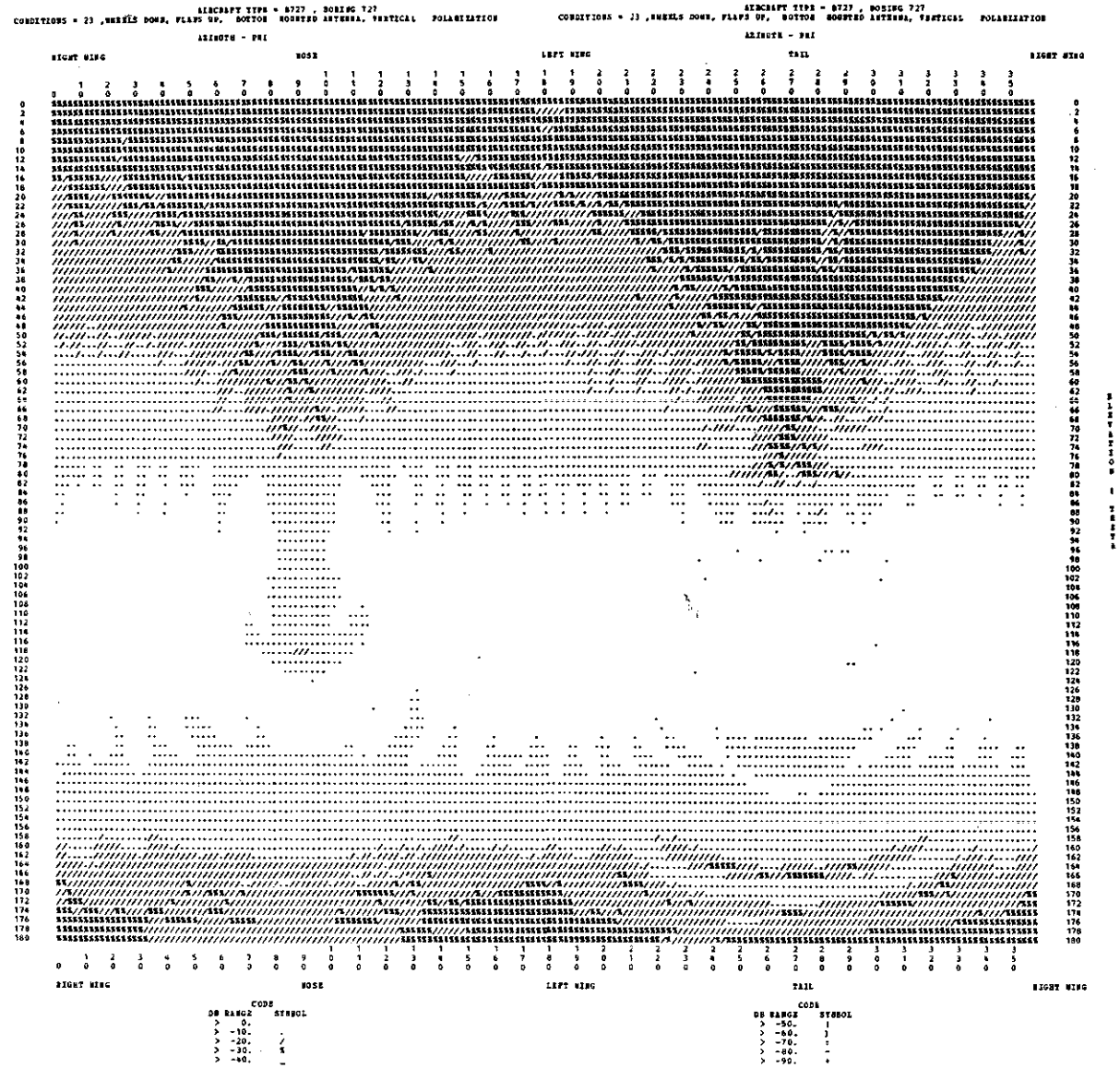

Fig. 10-5. Boeing 727; antenna position 2 (B); wheels down; vertical polarization.

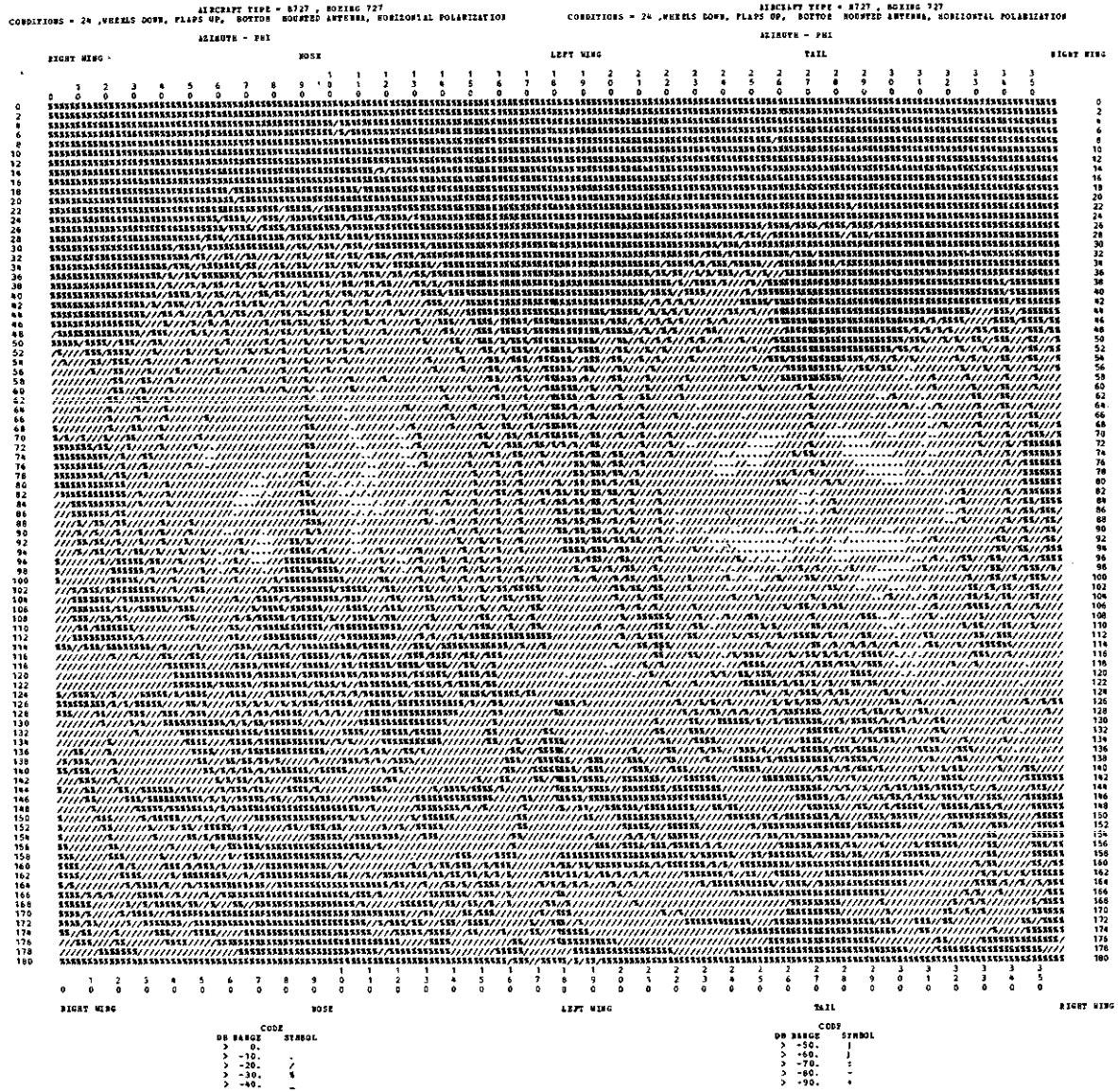

Fig. 10-6. Boeing 727; antenna position 2 (B); wheels down; horizontal polarization.

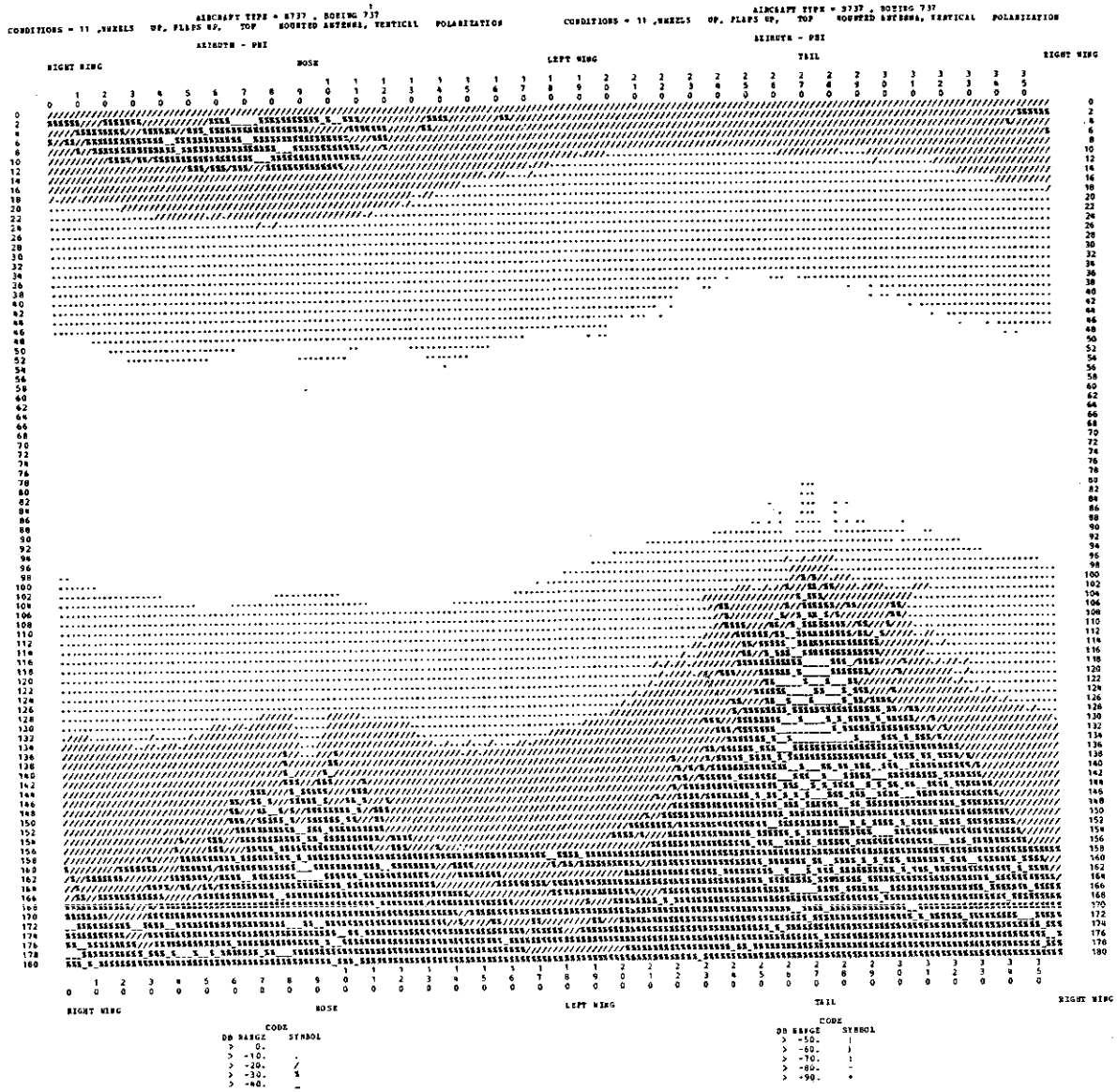

Fig. 11-1. Boeing 737; antenna position 1 (T); wheels up; vertical polarization.

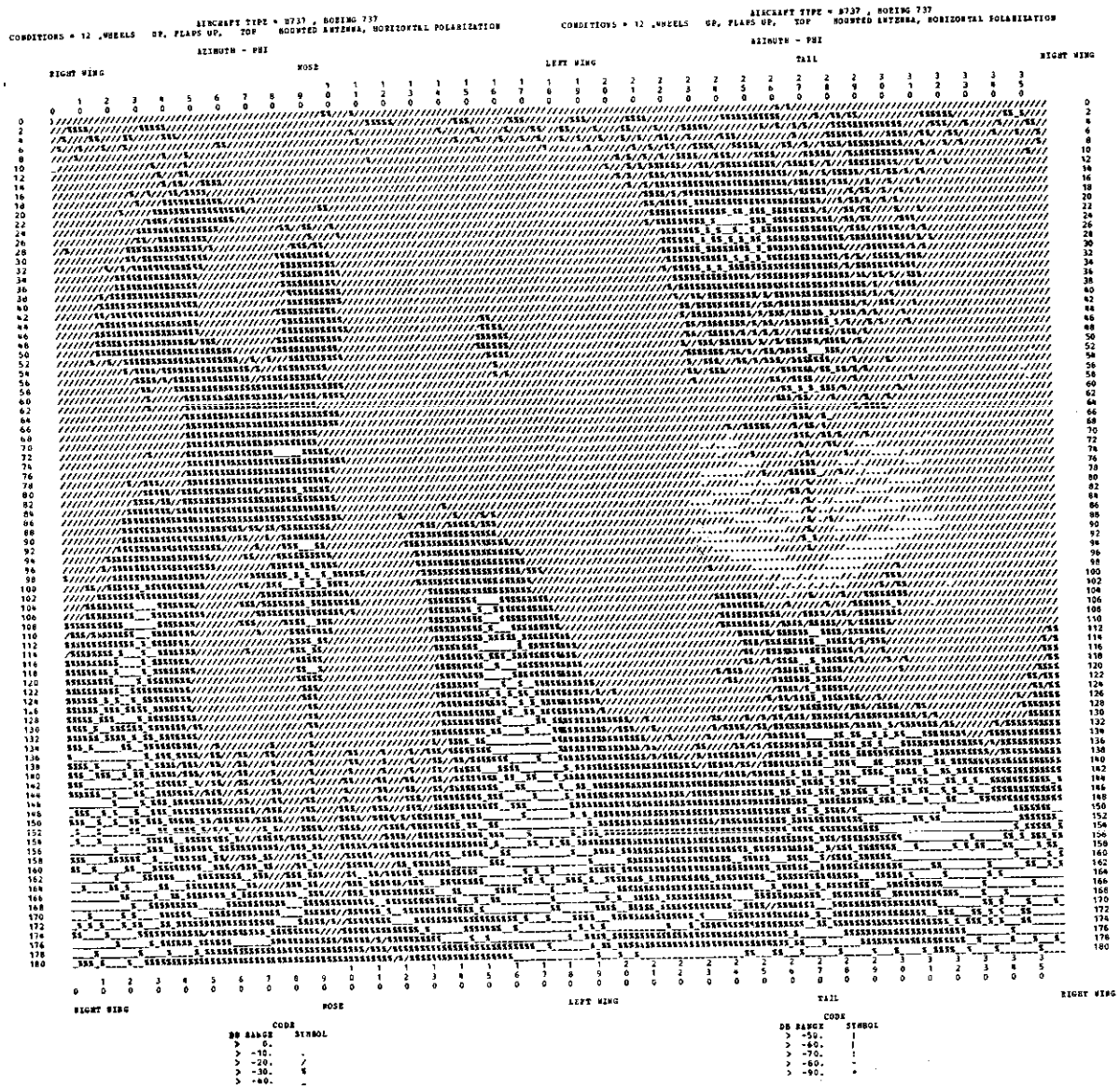

Fig. 11-2. Boeing 737; antenna position 1 (T); wheels up; horizontal polarization.

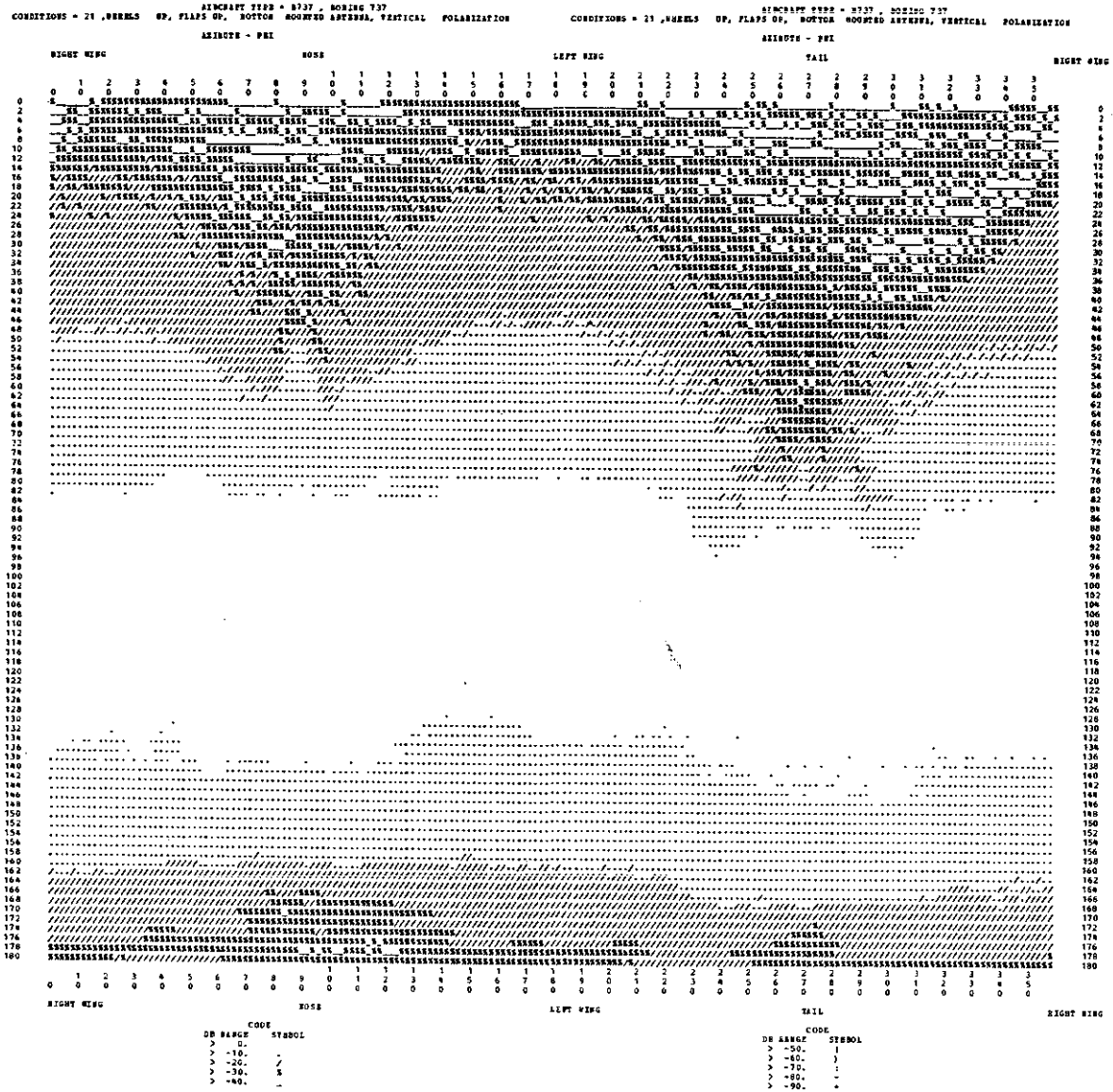

Fig. 11-3. Boeing 737; antenna position 2 (B); wheels up; vertical polarization.

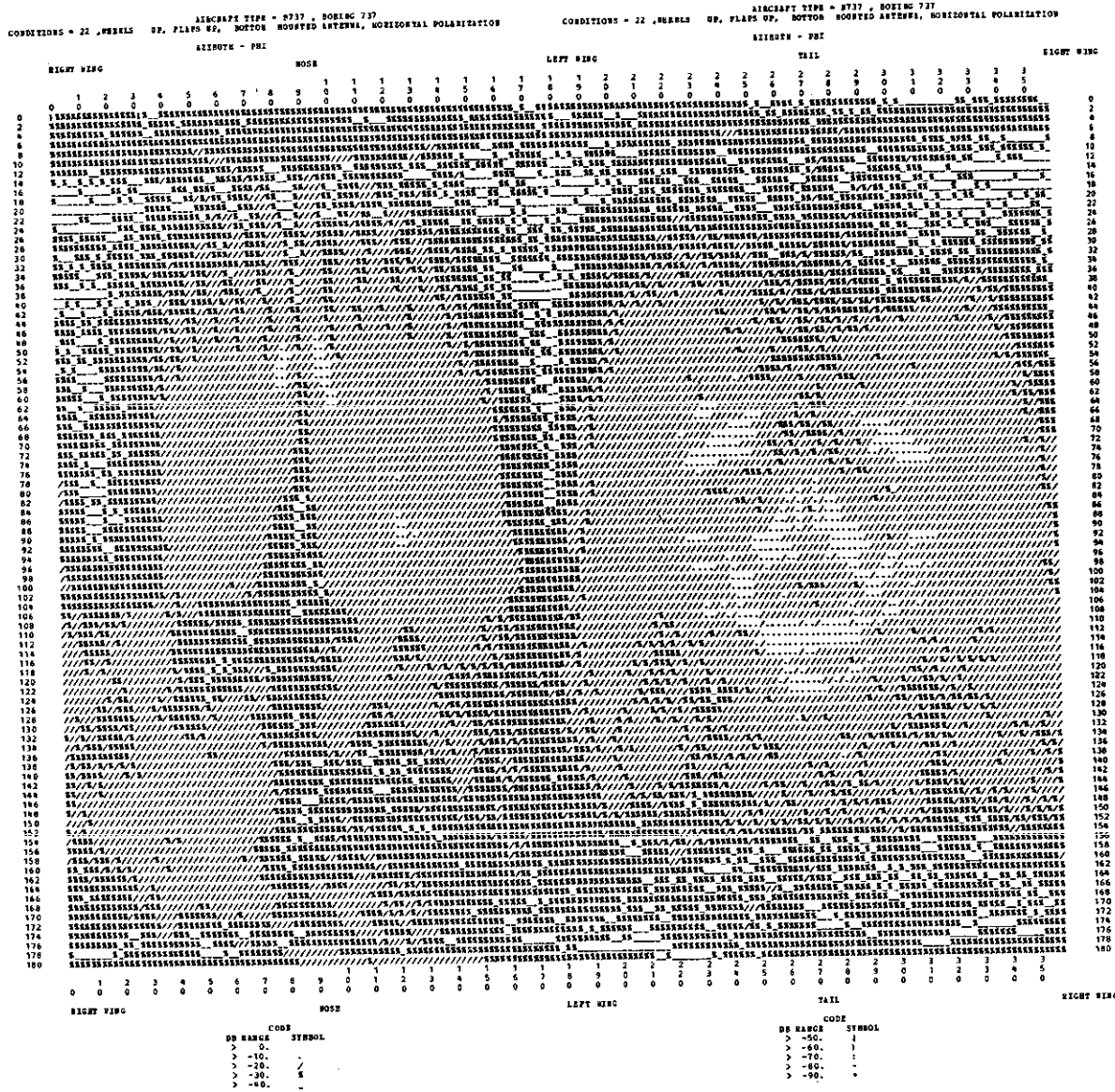

Fig. 11-4. Antenna position 2 (B); wheels up; horizontal polarization.

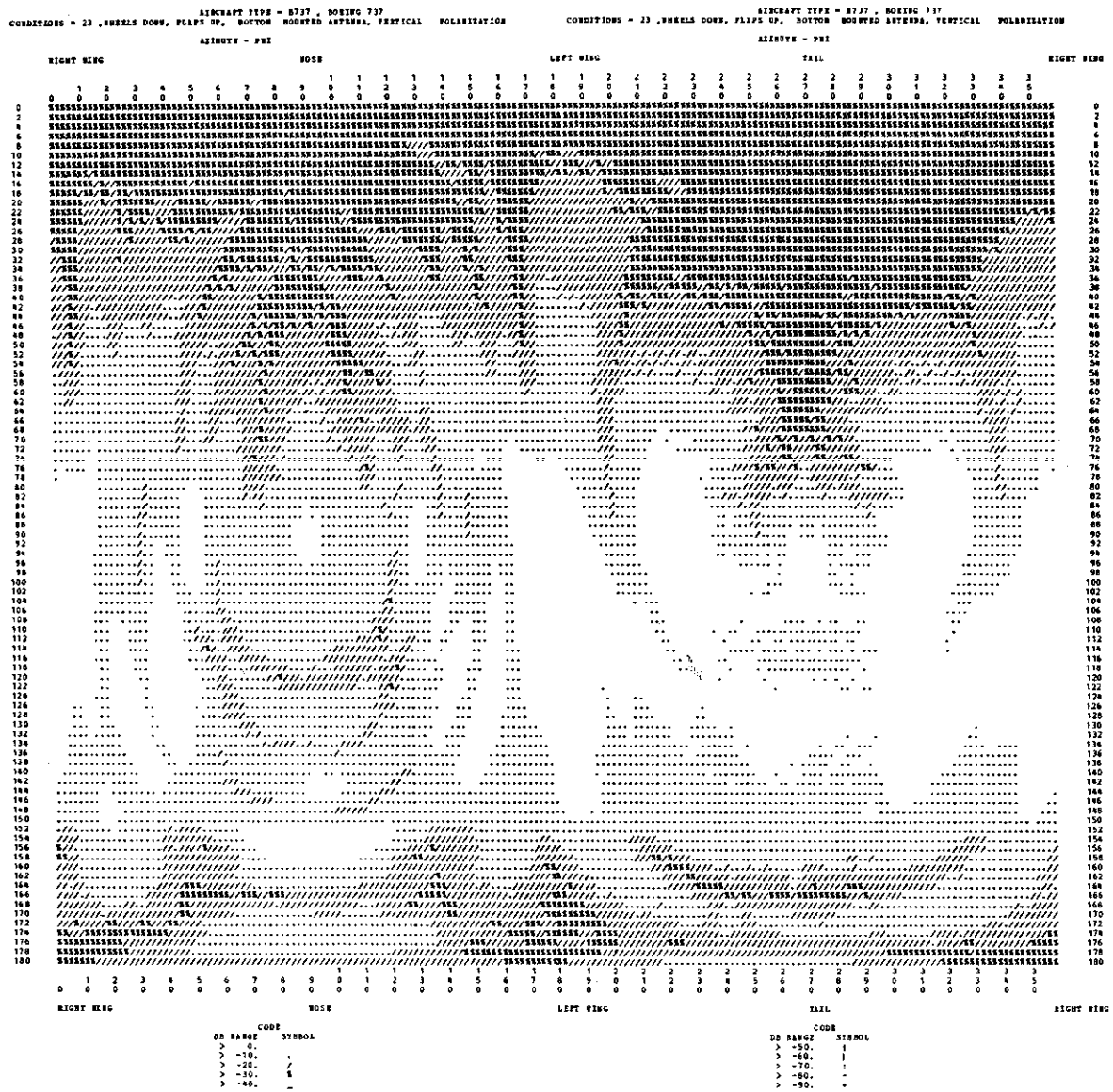

Fig. 11-5. Boeing 737; antenna position 2 (B); wheels down; vertical polarization.

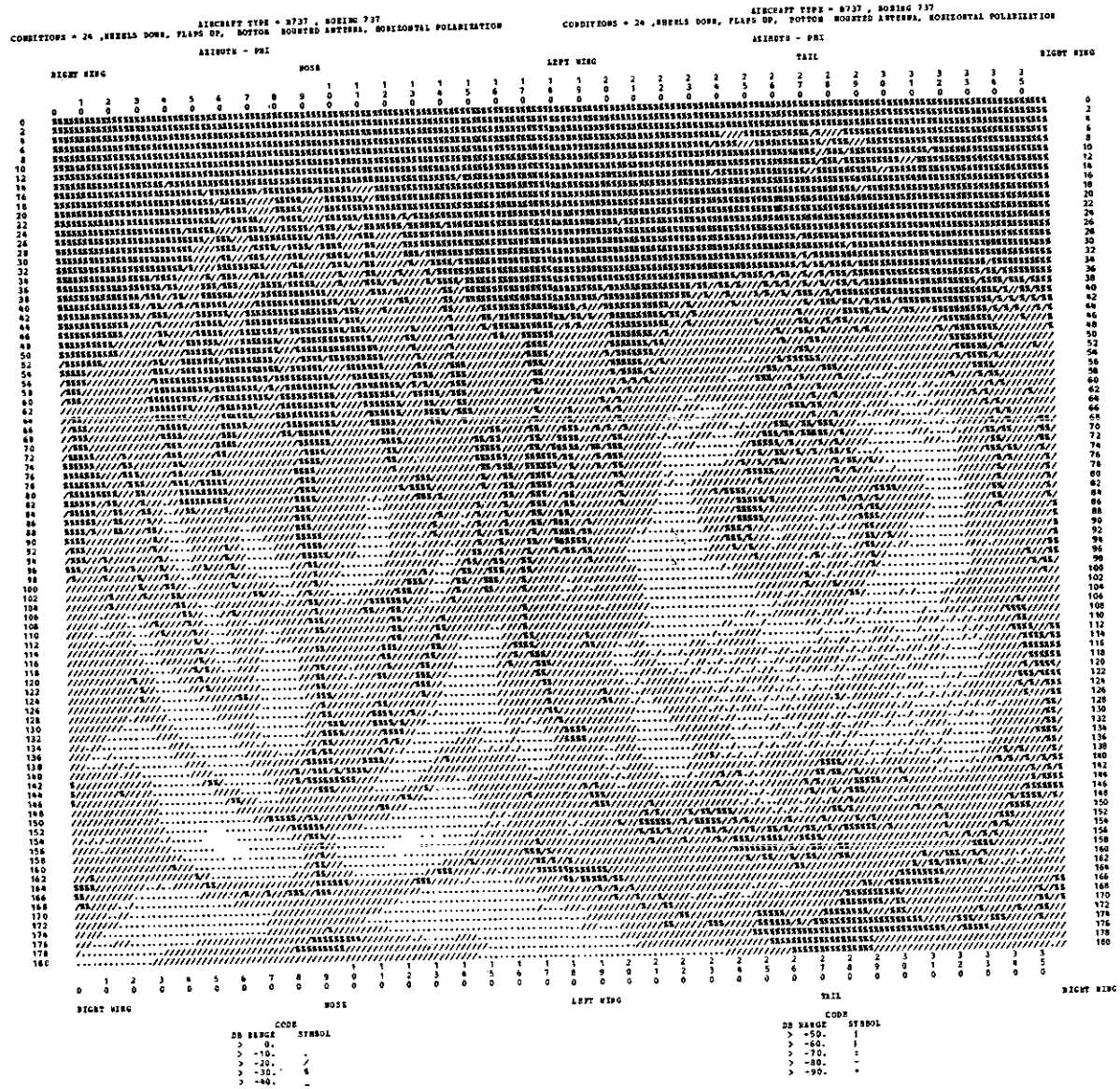

Fig. 11-6. Boeing 737; antenna position 2 (B); wheels down; horizontal polarization.

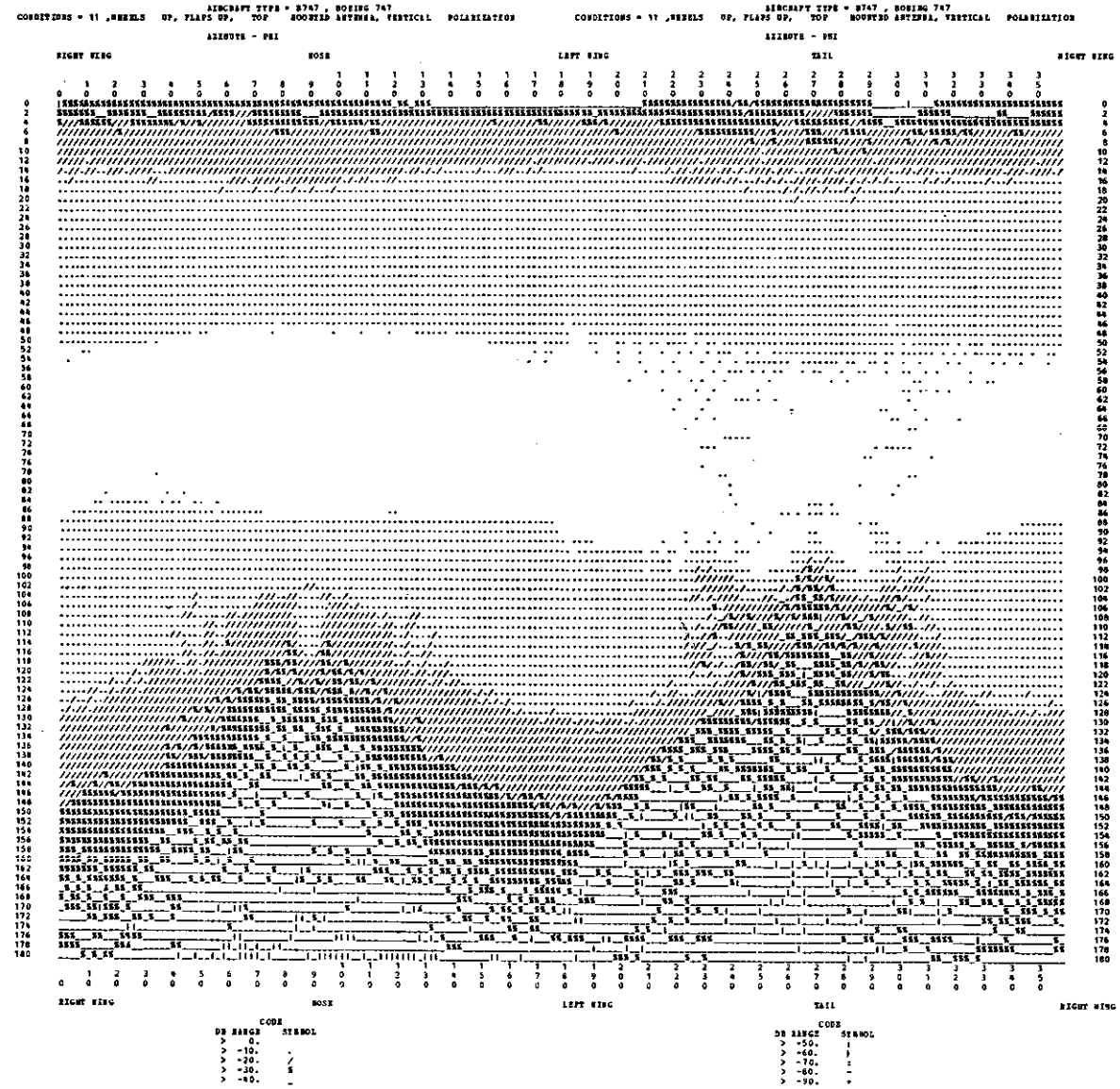

Fig. 12-1. Boeing 747; antenna position 1 (T); wheels up; vertical polarization.

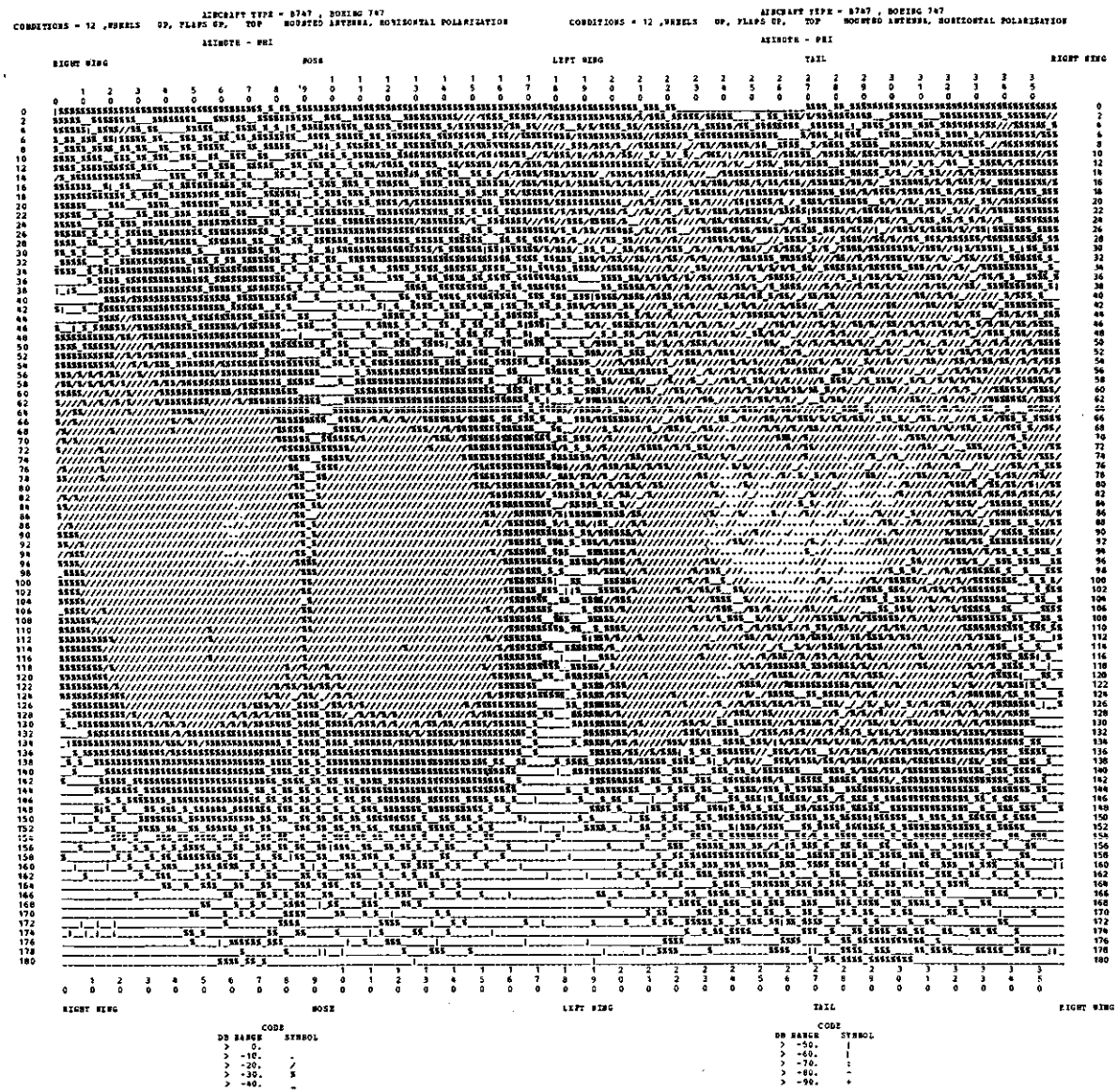

Fig. 12-2. Boeing 747; antenna position 1 (T); wheels up; horizontal polarization.

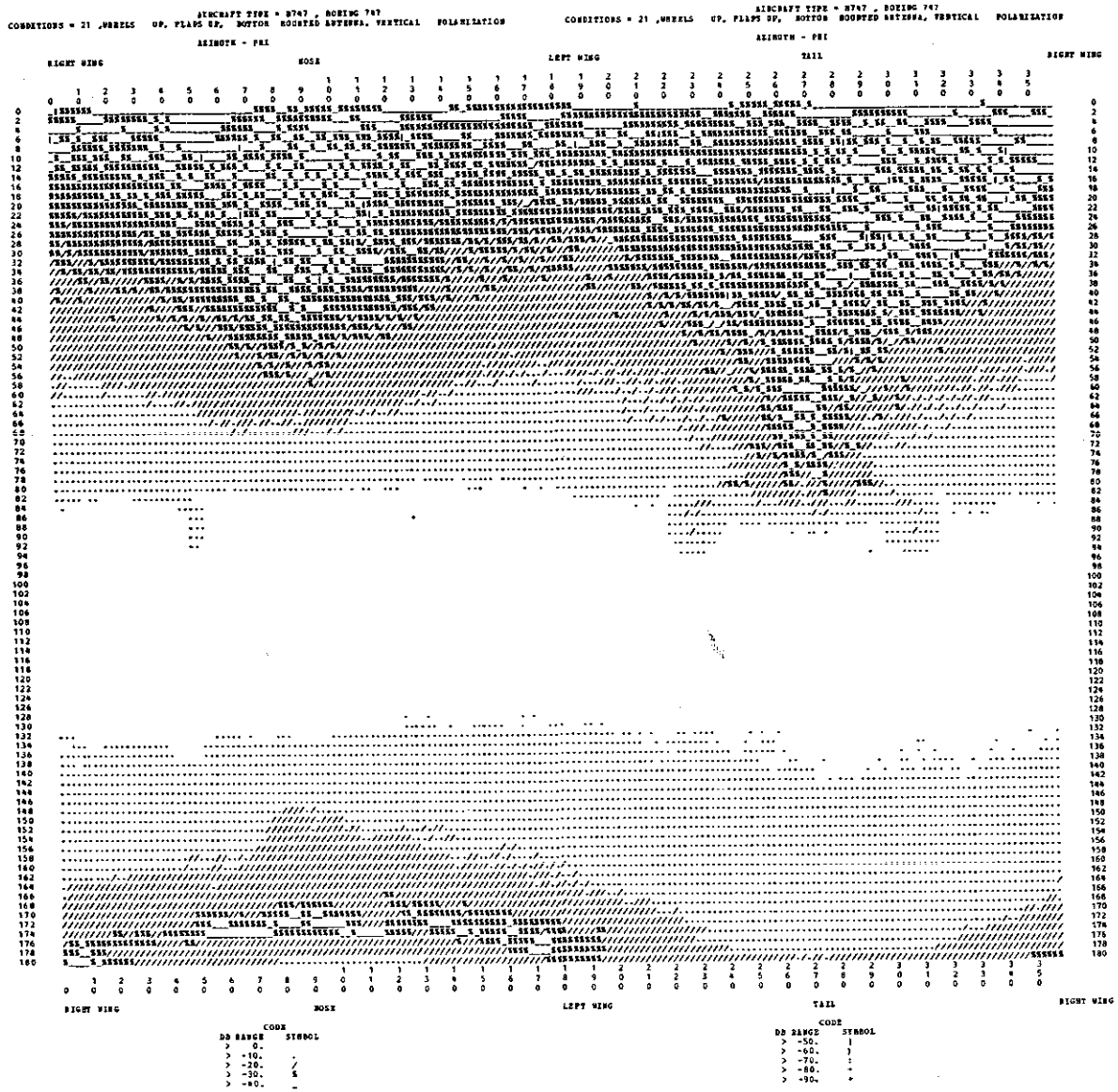

Fig. 12-3. Boeing 747; antenna position 2 (B); wheels up; vertical polarization.

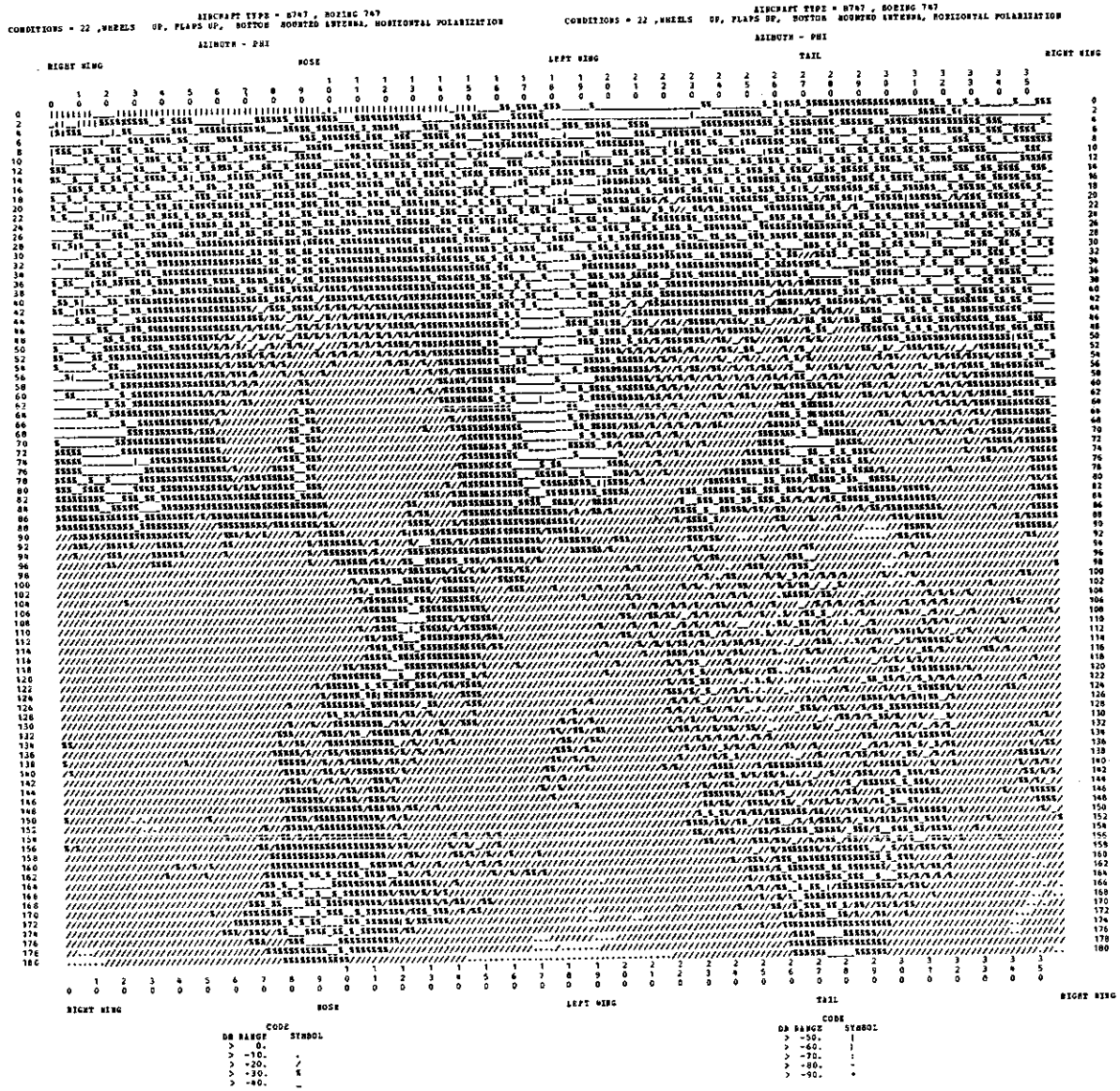

Fig. 12-4. Boeing 747; antenna position 2 (B); wheels up; horizontal polarization.

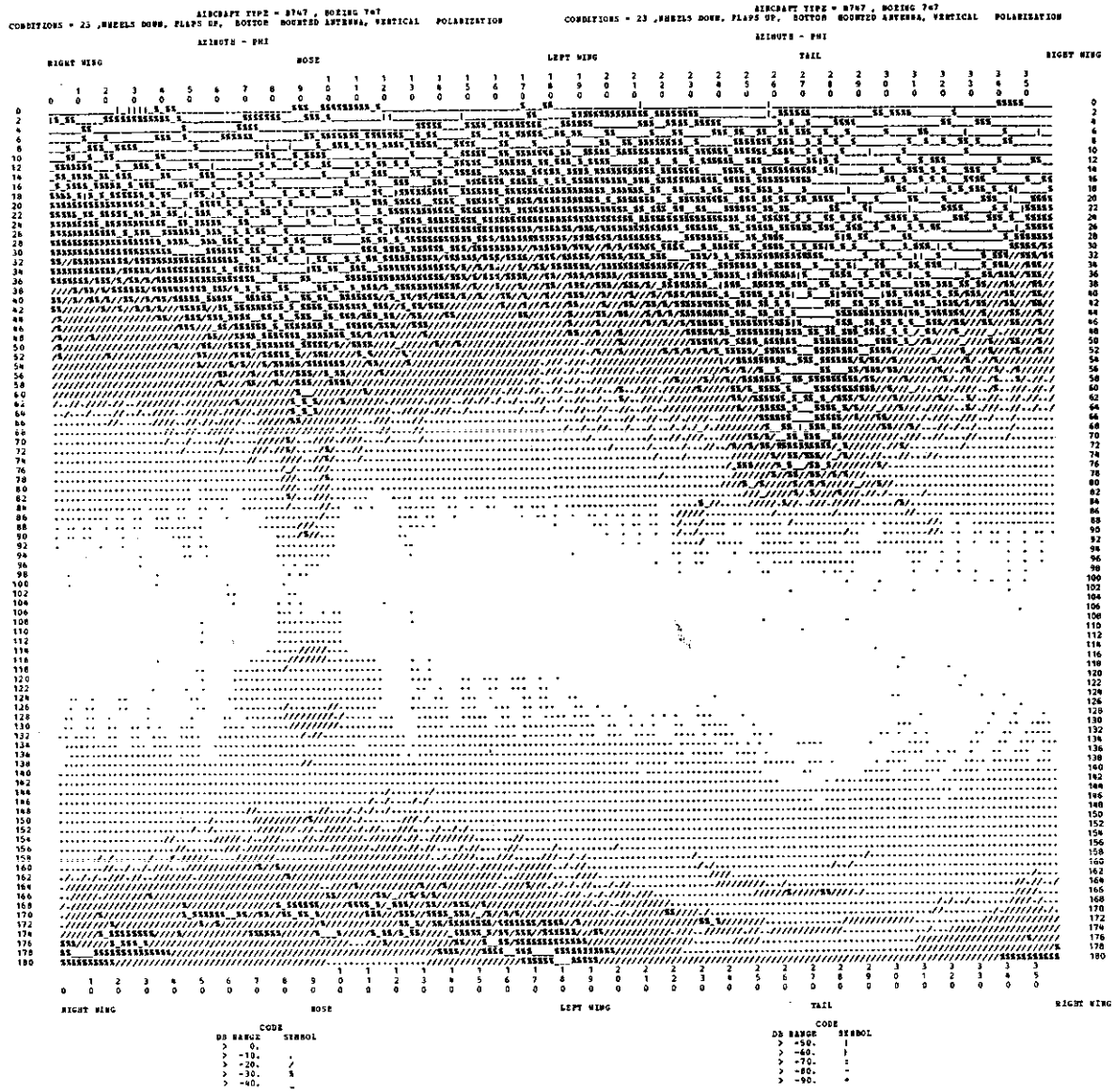

Fig. 12-5. Boeing 747; antenna position 2 (B); wheels down; vertical polarization.

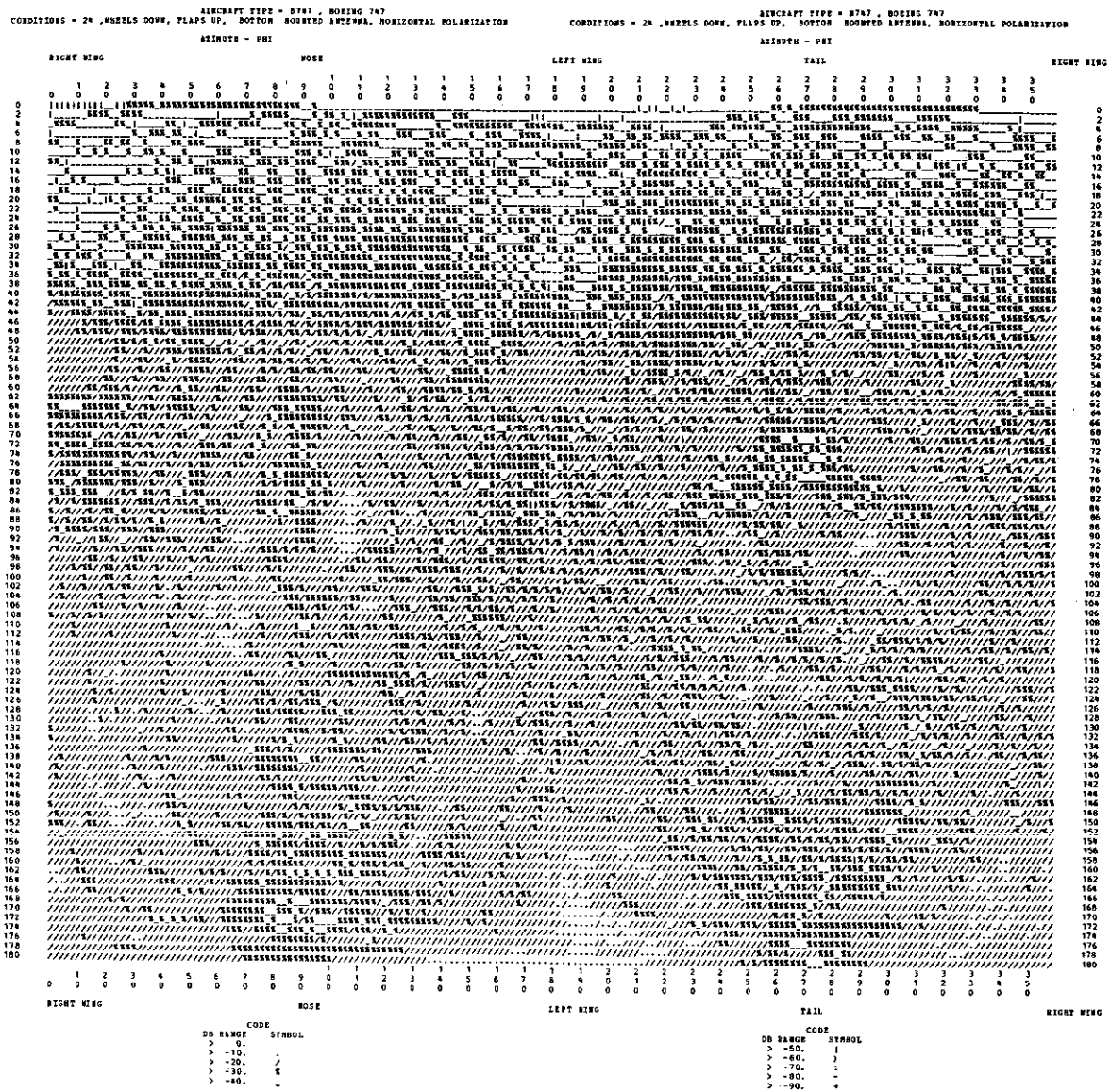

Fig. 12-6. Boeing 747; antenna position 2 (B); wheels down; horizontal polarization.

APPENDIX A

ANTENNA POSITION AND GEAR CONDITION CODING

1. General Aviation and Small Jet Models Only

Numerals of the two-numeral code, IJ, have the following meanings:

I denotes gear condition:

1. Wheels down, flaps up
2. Wheels down, flaps down
3. Wheels up, flaps up
4. Wheels up, flaps down.

J denotes antenna position as designated by numerals on Figs. 1-3 through 1-22.

2. Air Carrier Models Only

Numerals of the two-numeral code, MN, have the following meanings:

M denotes antenna position as designated on Figs. 1-23 through 1-26.

N denotes wheel condition (flaps always up), and polarization used:

1. Wheels up, vertical polarization
2. Wheels up, horizontal polarization
3. Wheels down, vertical polarization
4. Wheels down, horizontal polarization.

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