392

MSC Internal Note No. EE-66-9

Project Apollo

BLOCK II COMMAND AND SERVICE MODULE S-BAND OMNI ANTENNA PATTERNS

National Aeronautics and Space Administration

HOUSTON, TEXAS

Manned Spacecraft Center

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(CATEGORY)

392

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BLOCK II COMMAND AND SERVICE MODULE S-BAND OMNI ANTENNA PATTERNS

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Approved by A B Eichmeier
for Ralph S. Sawyer, Chief
Instrumentation & Electronic
Systems Division

December 1966

NASA/MSC
Houston, Texas

I. INTRODUCTION

The following is a brief description of the test setup, measurements and results of the Block II S-band omni pattern measurements on the CSM. The measurements were performed at the Manned Spacecraft Center Antenna Range (Building 14) during October and November 1966.

The pattern numbers, locations, frequencies, polarizations and gains are given below:

No.	Location	Freq.	Polarization	Gain of "0" db on RDP
18	$\phi=315^\circ$	2106	RCP	6.0
19	$\phi=315^\circ$	2106	LCP	4.0
20	$\phi=135^\circ$	2106	RCP	5.7
21	$\phi=135^\circ$	2106	LCP	7.0
22	$\phi=135^\circ$	2287	RCP	6.6
23	$\phi=135^\circ$	2287	LCP	6.6
24	$\phi=315^\circ$	2287	RCP	4.1
25	$\phi=315^\circ$	2287	LCP	4.1
26	$\phi=225^\circ$	2287	RCP	6.7
27	$\phi=225^\circ$	2287	LCP	5.0
28	$\phi= 45^\circ$	2287	RCP	4.7
29	$\phi= 45^\circ$	2287	LCP	3.7
30	$\phi=225^\circ$	2106	RCP	5.6
31	$\phi=225^\circ$	2106	LCP	5.6
32	$\phi= 45^\circ$	2106	RCP	5.1
33	$\phi= 45^\circ$	2106	LCP	5.1
A	Composite	2287	RCP	6.7
B	Composite	2106	RCP	6.0

II. TEST SET-UP

The test set-up for the antenna pattern measurements consisted of a transmitting system, a receiving system (including the spacecraft antennas on a full scale CSM mockup), a recording system and a positioner for obtaining various spacecraft orientations. The transmitting, receiving and positioning systems are shown in the photograph in Figure 1. The recording equipment is located in the Remote Control Room of Building 14.

The 6000 pound mockup of the CSM is elevated 35 feet on the Receiver Support Tower (positioner). The Command Module (CM) is covered with special cork and aluminum foil to simulate the electrical characteristics of the heat shield on the Block II spacecrafts.

The four antennas tested are quartz embedded helices supplied by Amecom and are mounted on the maximum radius point of the CM (X_c=20.76") at $\Phi = 45^\circ$, 135°, 225°, and 315° ($\theta = 90^\circ$) as shown in the coordinate system in Figure 2. The recessed or "hot side" antennas are located at $\Phi = 135^\circ$ and $\Phi = 225^\circ$. These antennas are covered with a 0.7" ablator plug which is inserted into a fiber glass sleeve. The aluminum foil is removed from a 7.5" radius circle around the recessed antennas. The flush mounted or "cold side" antennas ($\phi = 45^\circ$, 315°) also have the fiber glass sleeve; however, the quartz surface of the antenna is mounted flush with the ablator as practicable and the aluminum foil is d-c bonded to the antenna ground. The axis of each antenna is mounted perpendicular to the X axis of the spacecraft.

The criteria used for mounting the antennas on the mockup was obtained from NAA and the antenna vendor. Since the antenna axis is mounted perpendicular to the spacecraft X axis, the antennas will vary slightly in being truly flush from spacecraft to spacecraft due to the ablator radius tolerances at station Xc = 20.76". These variations will cause beam shifting which is discussed in section III of this report.

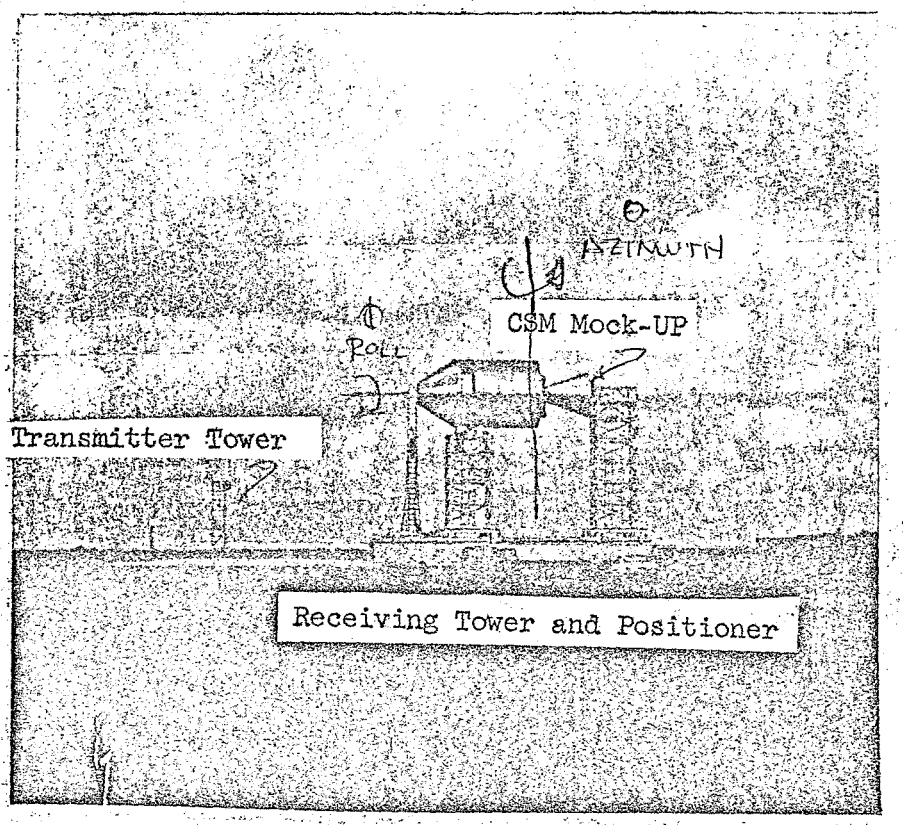


FIGURE 1. ANTENNA PATTERN TEST SET-UP

In measuring the radiation for various spacecraft orientations conical patterns were obtained by rotating the mockup about the X axis (Φ variation) for fixed values of θ every 2 degrees between 0 and 180 degrees. The locus of a conical cut at $\theta \approx 20^{\circ}$ is shown in Figure 2. The radiation distribution printout (RDP) shows the level in negative db for 16,380 attitudes with "0" db corresponding to a gain given on the bottom of each pattern referenced to a circularly polarized perfect isotropic source. For example, on pattern 18 the printout of a "0" on the RDP corresponds to a gain of 6 db above a perfect circular isotropic level. A printout of "1" corresponds to 5 db, a printout of 2 corresponds to 4 db, etc.

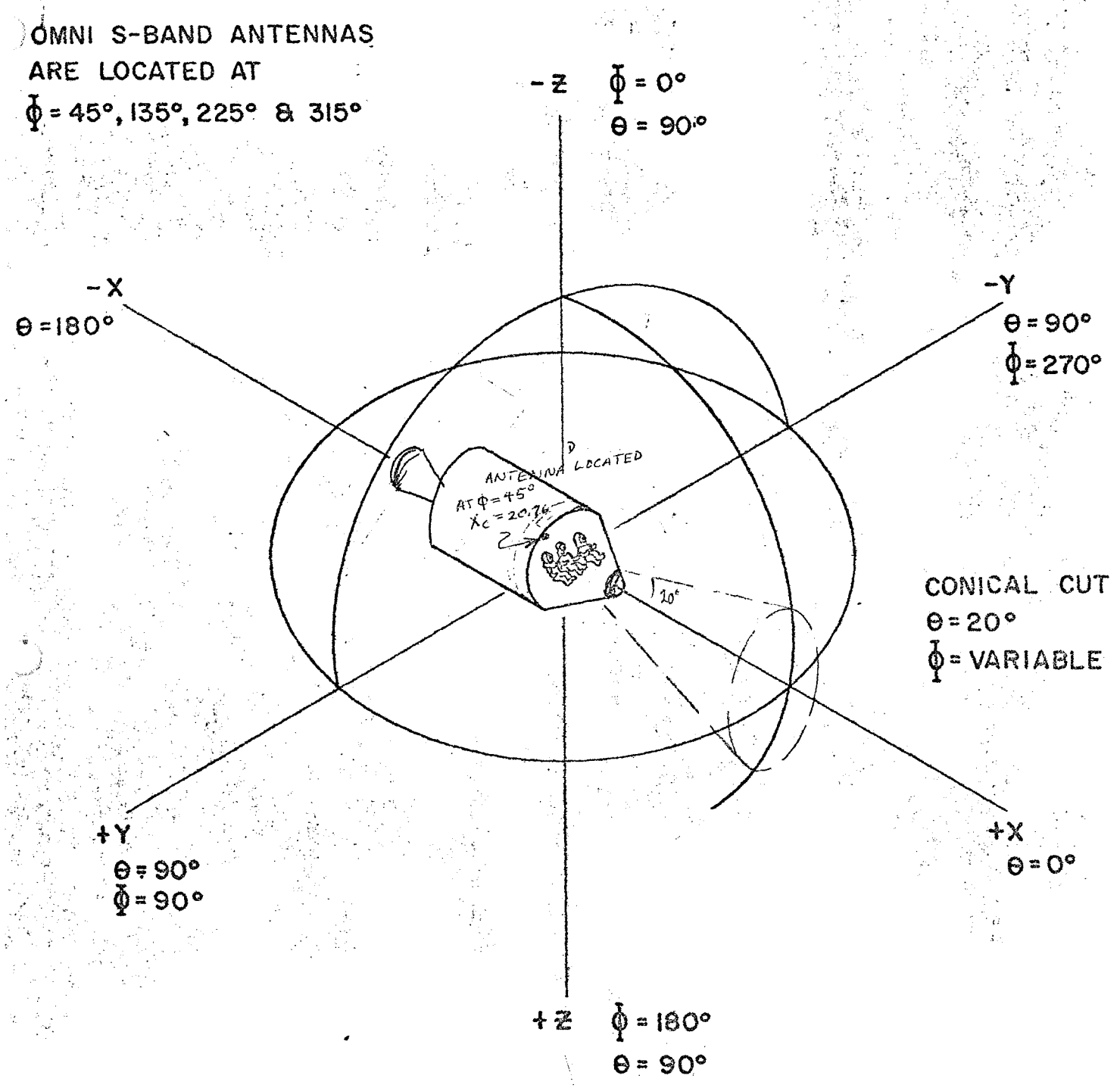


FIGURE 2

CO-ORDINATE SYSTEM
FOR
COMMAND & SERVICE MODULE

III. MEASUREMENTS

The measurements were made using a circularly polarized six foot diameter parabolic transmitting antenna at a range length of 2,000 feet from the spacecraft (receiving) antennas. Using the ground reflection range mode, the six foot dish was adjusted to a height of 7.0 feet at 2106 MHZ, the spacecraft receive frequency, and 6.14 feet at 2287 MHZ, the spacecraft transmit frequency.

Before the spacecraft antenna measurements were made, the field was probed with a standard gain horn to insure proper circularity and minimum phase taper of the transmitted field. The field was probed every 30 degrees for an area of $\pm$ 8 feet in height and $\pm$ 15 feet horizontally. Depth probing was performed for $\pm$ 10 feet. The maximum variation of field axial ratio and field taper was adjusted to $\pm \frac{1}{2}$ db for the volume defined above.

The overall error associated with the patterns is $\pm$ 1 db within the half power (3 db) beamwidth of each antenna and $\pm$ 1.5 db outside the main beam except for the area when the main lobe was pointing into the fiber glass tower. The effect of the tower causes an error of up to $\pm$ 7 db in the region between -135° and -45° in roll from the axis of the antenna. For the antenna located at $\Phi = 45^\circ$ ($\theta = 90^\circ$) the main lobe points into the fiber glass tower for roll angles between $\Phi = 270^\circ$ and $\Phi = 0^\circ$. This error is especially noticable for azimuth (θ) angles between 0° and 20° and between 170° and 180°. A correction can be made to eliminate the tower error by utilizing the symmetry of the patterns. For the $\Phi = 45^\circ$ antenna the θ points at $\Phi = 92^\circ$ replace those at $\phi = 358^\circ$, $\Phi = 94^\circ$ replaces $\Phi = 356^\circ$, etc. The final report on these patterns will have the tower effects eliminated.

The absolute gain measurements were performed using a standard gain horn (gain $\approx$16 db) with a conservatively stated accuracy of $\pm$0.5 db. Also, the gain was determined by using the directivity readings on the pattern integrator and assuming a 1 db (80%) efficiency on the flush mounted antenna and 1.4 db efficiency on the recessed antennas. The gain measurements with the reference horn were repeated numerous times to insure a reliable measurement. The integrator gain (with efficiency assumed) correlated closely with actual measured values.

In addition to normal system and tower errors there also is an error which is due to the slight variations in the mounting of the antennas as discussed in section II. Since these variations will also be present in actual spacecraft mounting the pattern prediction is slightly limited. In pattern 18 and 20 the main lobe is shifted 30° - 40° off axis; whereas, the corresponding patterns of 30 and 32 are not shifted. It is believed that this shifting is due to slight differences in the mounting. The beam shift does not appear to affect the forward and rear levels or percent coverage factors.

The composite patterns A and B have additional errors in portions of the patterns due to rounding-off the maximum gains after a correction factor is added. For example, on composite A the maximum gain is taken as 6.7 db which corresponds to the $\Phi = 225^{\circ}$ antenna. The $\Phi = 135^{\circ}$ antenna has a maximum gain of 6.6 db; therefore, the levels in the 135° portion of the pattern are 0.1 db high. There is no additional error on the 45° since a 2 db correction factor changes its 4.7 db gain to the composite maximum of 6.7 db. On the $\Phi = 315^{\circ}$ antenna a 3 db correction factor scales the 4.1 db gain to 7.1 db and the resulting additional error causes the levels in the $\Phi = 315^{\circ}$ region to be 0.4 db low. Also, for azimuth (θ) angles of 0° - 25° and 160° - 180° the tower effects are noticeable with the printing of 0's, 1's and 2's on the RDP.

IV. RESULTS

The results of the Block II CSM patterns are described in general terms with the following statements:

a. The percent coverage of the antenna system at a perfect circular isotropic level is 80% or better for most of the patterns. Using the perfect circular isotropic level there is no 3 db loss for polarization with a circularly polarized ground antenna.

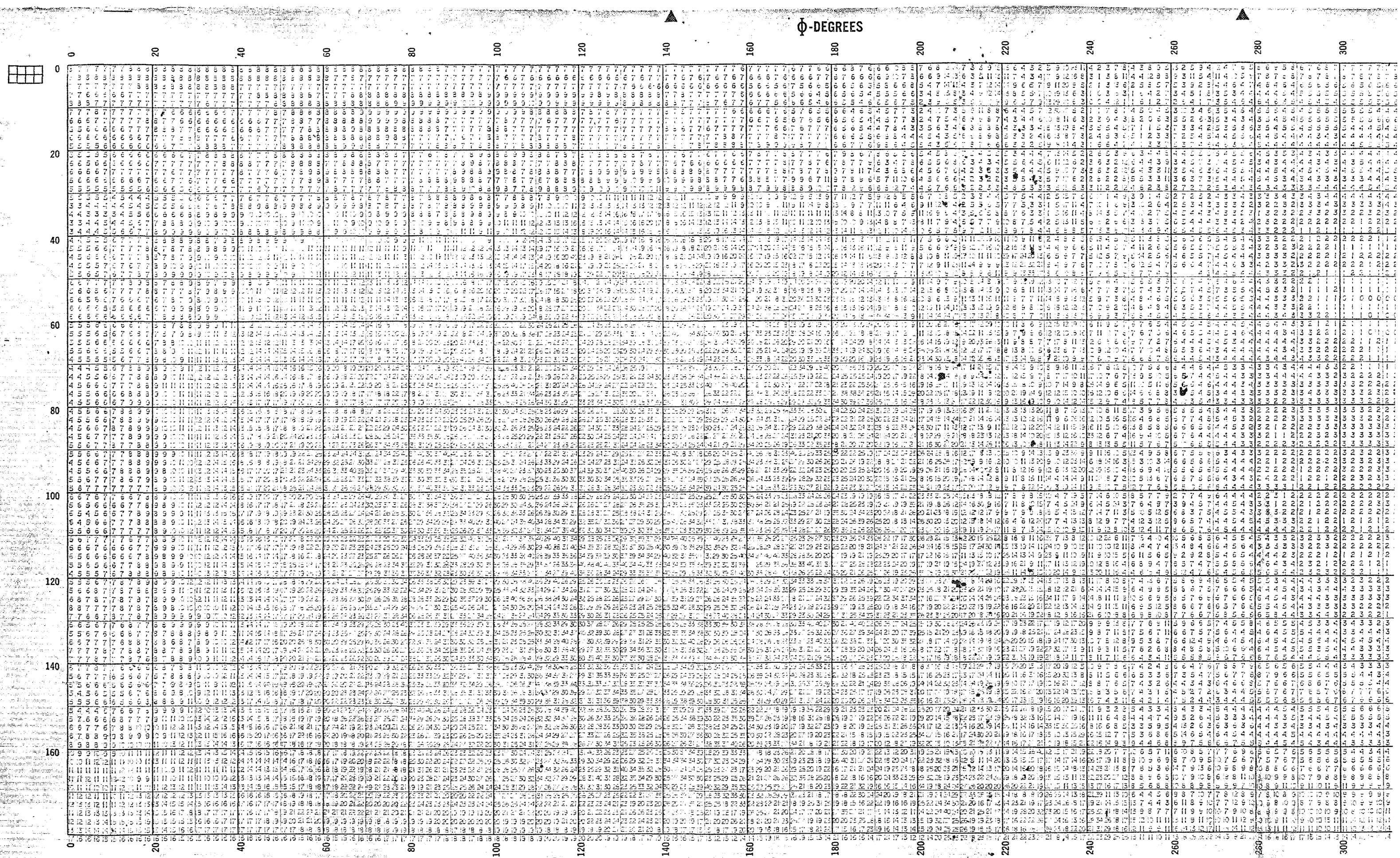
b. The maximum worst case levels measured off of the nose ($\theta = 0^{\circ}$) are 5 db below a circularly polarized perfect isotropic source.

c. The maximum worst case levels measured off of the tail ($\theta = 180^{\circ}$) are 16 db below a circularly polarized perfect isotropic source.

d. The flush mounted antennas have an excessive axial ratio ($\sim$11 db) especially at the spacecraft receive frequency of 2106 MHZ. The axial ratio at the spacecraft transmit frequency 2287 MHZ is not as bad ($\sim$8 db). The percent coverage for the flush mounted antennas with axial ratio losses considered is approximately the same as the recessed antennas at the zero db circular isotropic level.

e. The forward and rear coverage is slightly better with the flush mounted antennas probably because the radiating portion is closer to the skin of the ablator.

A more detailed explanation of pattern results will be given in the final report.



TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT:

DATE: 10/19/66 PATTERN NO: 13 ORGANIZATION: ESD-ESB-ANTENNA SYSTEMS SECTION ENGRS:

GAIN PLOT: X POLARIZATION COMPONENT RECORDED: LINEAR □Φ, □θ, □ 45, □ 135; CIRCULAR ☒ RH □

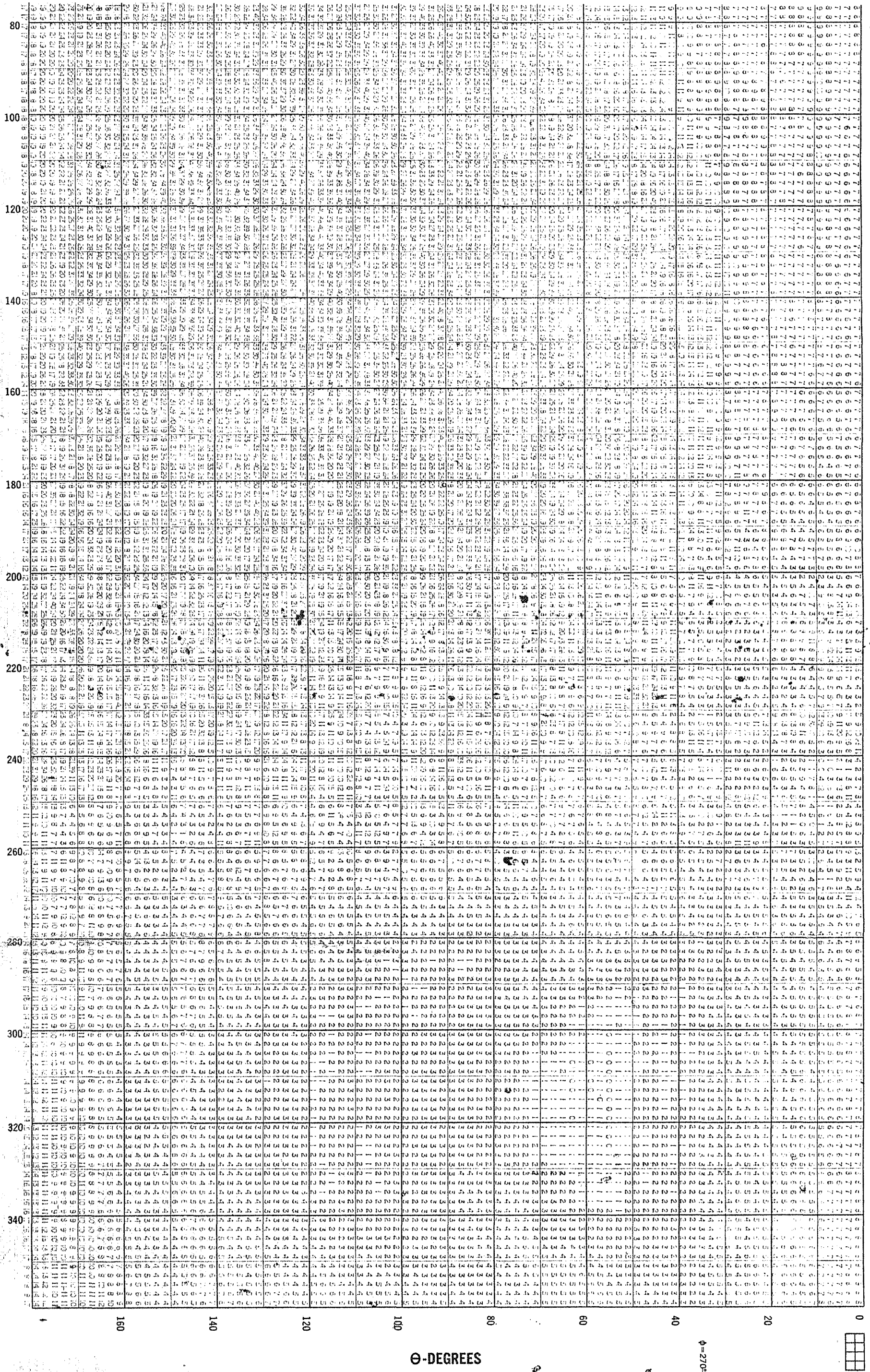
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF ± 6.0 DB RELATIVE TO AN ISOTROPIC

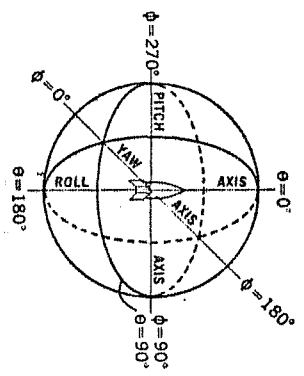
INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: _____

ESCORT ANTENNA SYSTEMS SECTION ENGRS: _____

GAIN PLOT: X POLARIZATION COMPONENT RECORDED: LINEAR ☐ φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR X RH ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + X 6.0 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



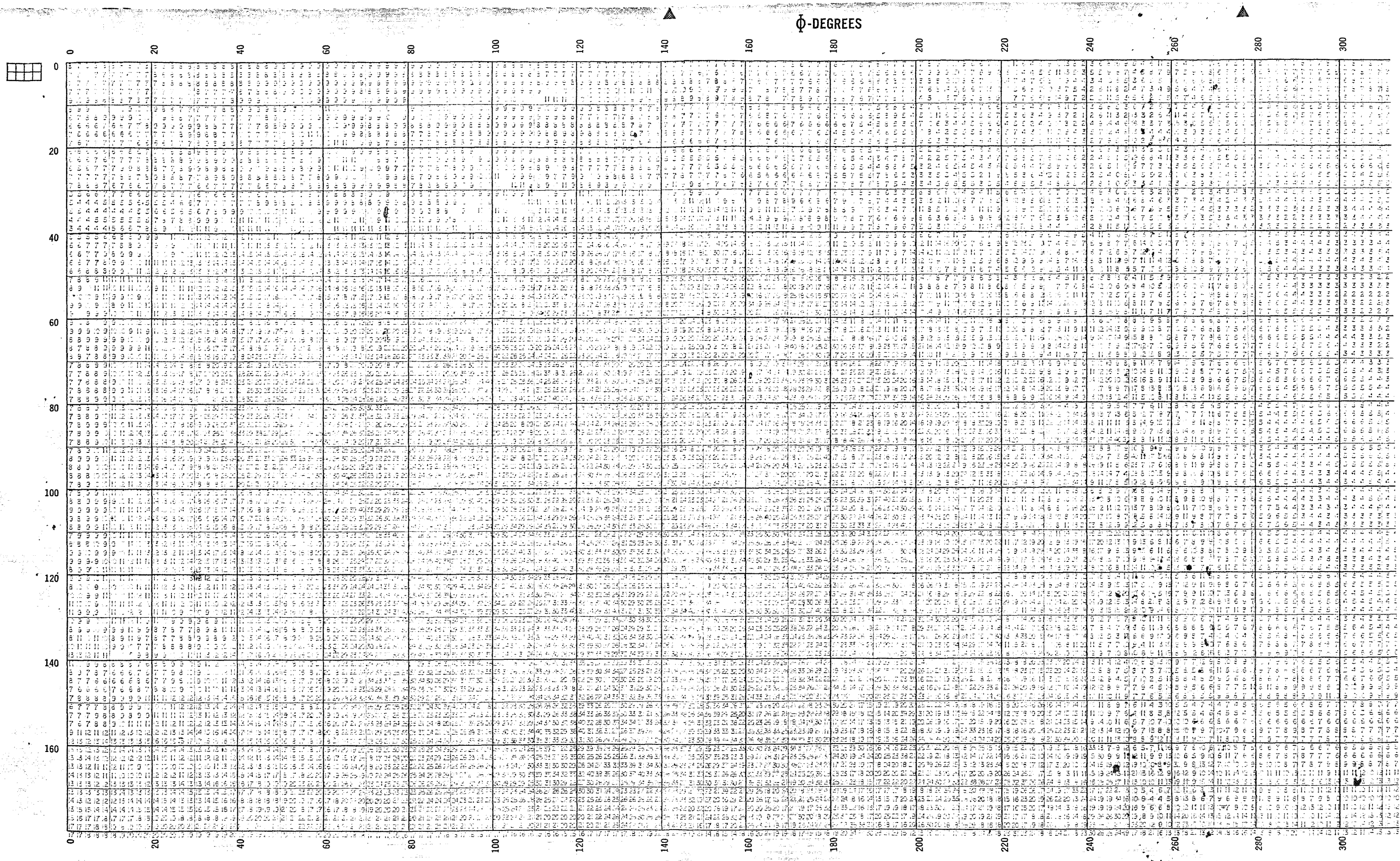


REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A



TEST PROGRAM OR VEHICLE: [illegible] INSTRUMENTATION SYSTEM: [illegible] PROJECT: [illegible]

DATE: [illegible] PATTERN NO: 19 ORGANIZATION: [illegible] ENGRS: [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☒ LH

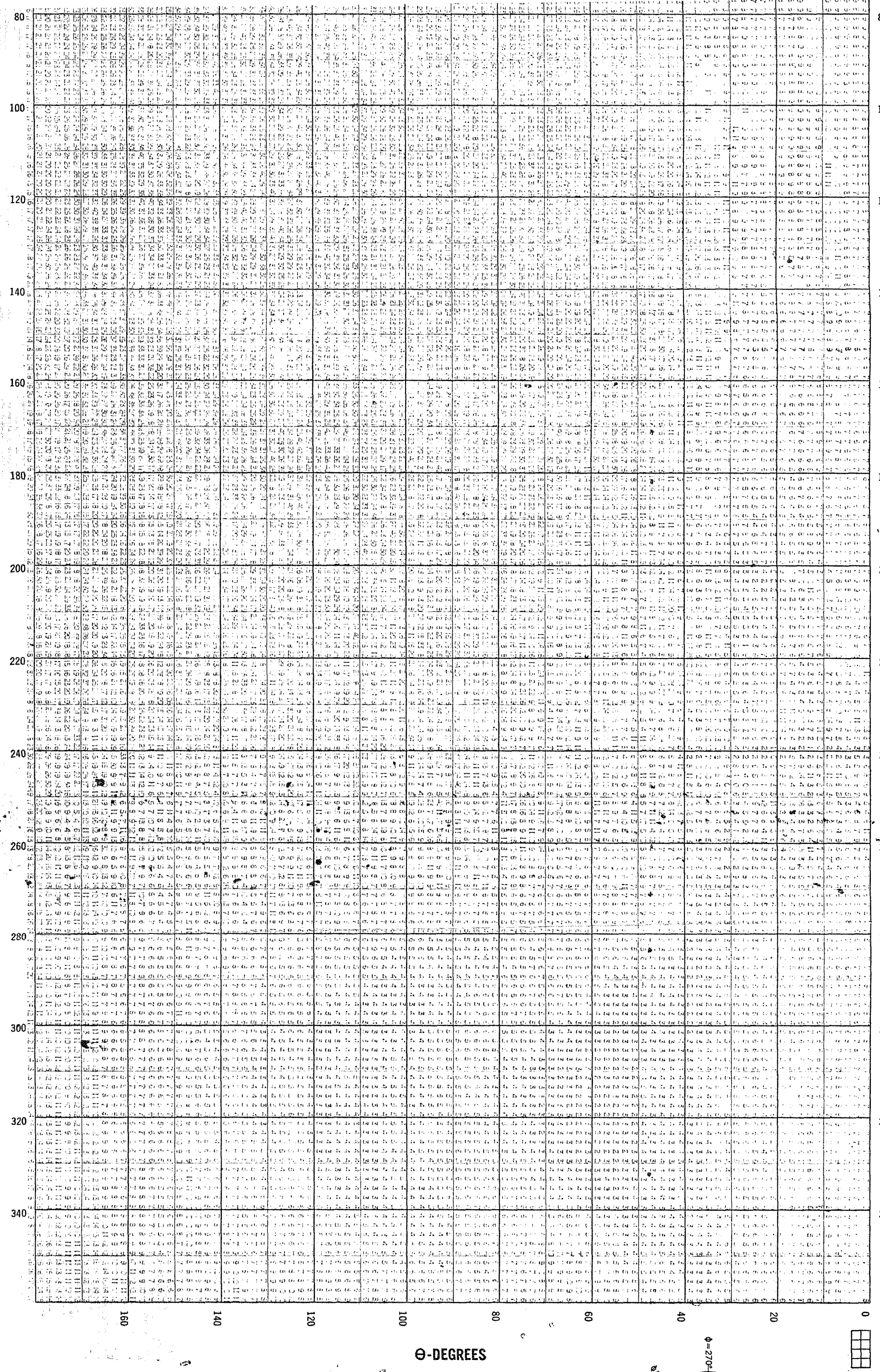
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF ± 4.0 DB RELATIVE TO AN ISOTROPIC A

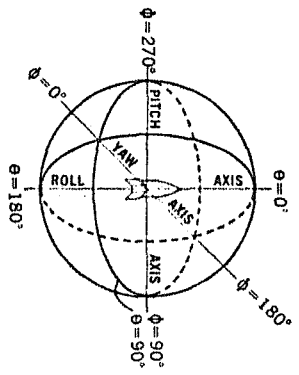
ORIENTATION SYSTEM: [illegible] PROJECT: [illegible] ENGRS: [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ Θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF ± 4.0 DB RELATIVE TO AN ISOTROPIC ANTENNA

OF CIRCULAR POLARIZATION



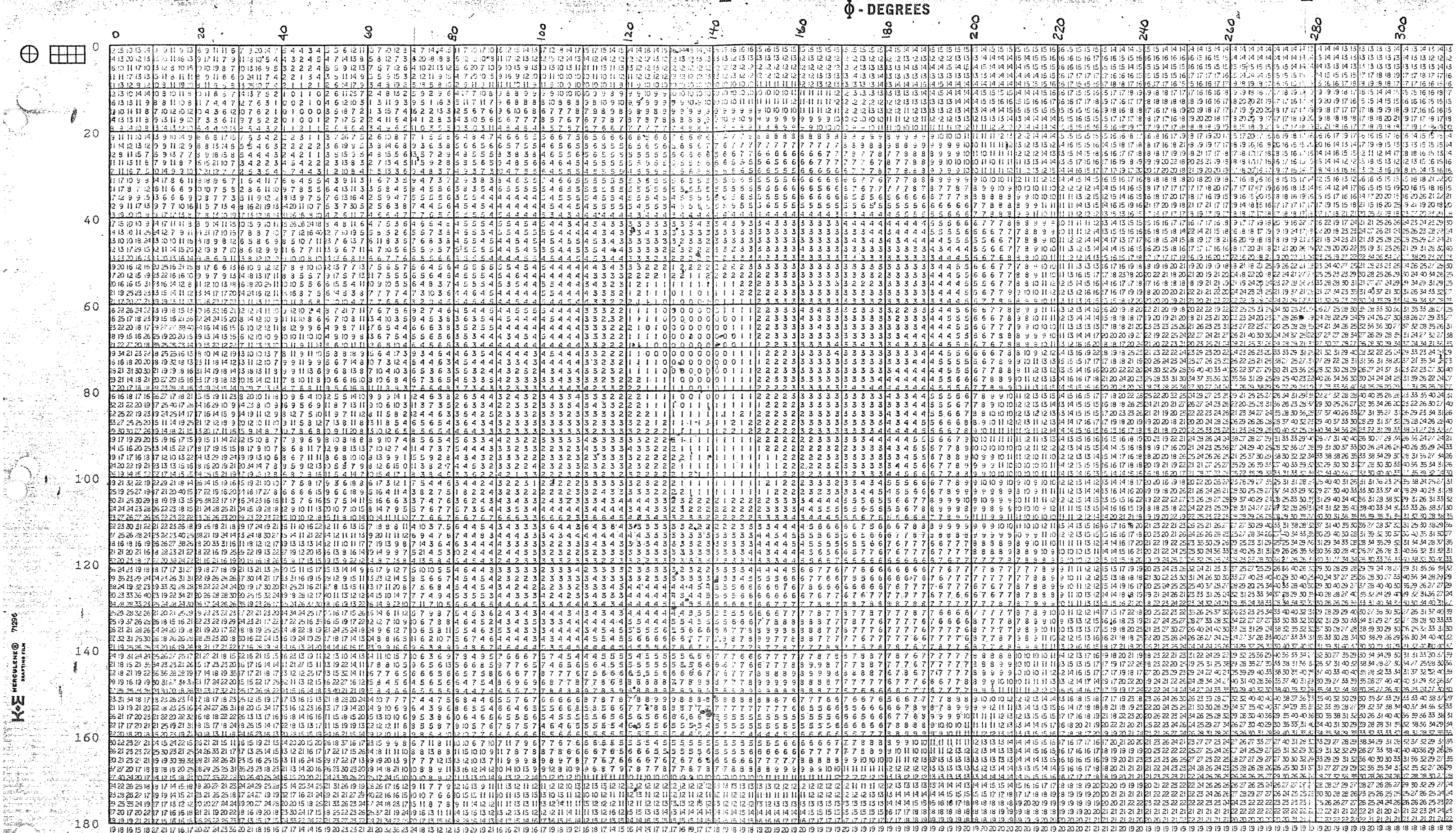


REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A



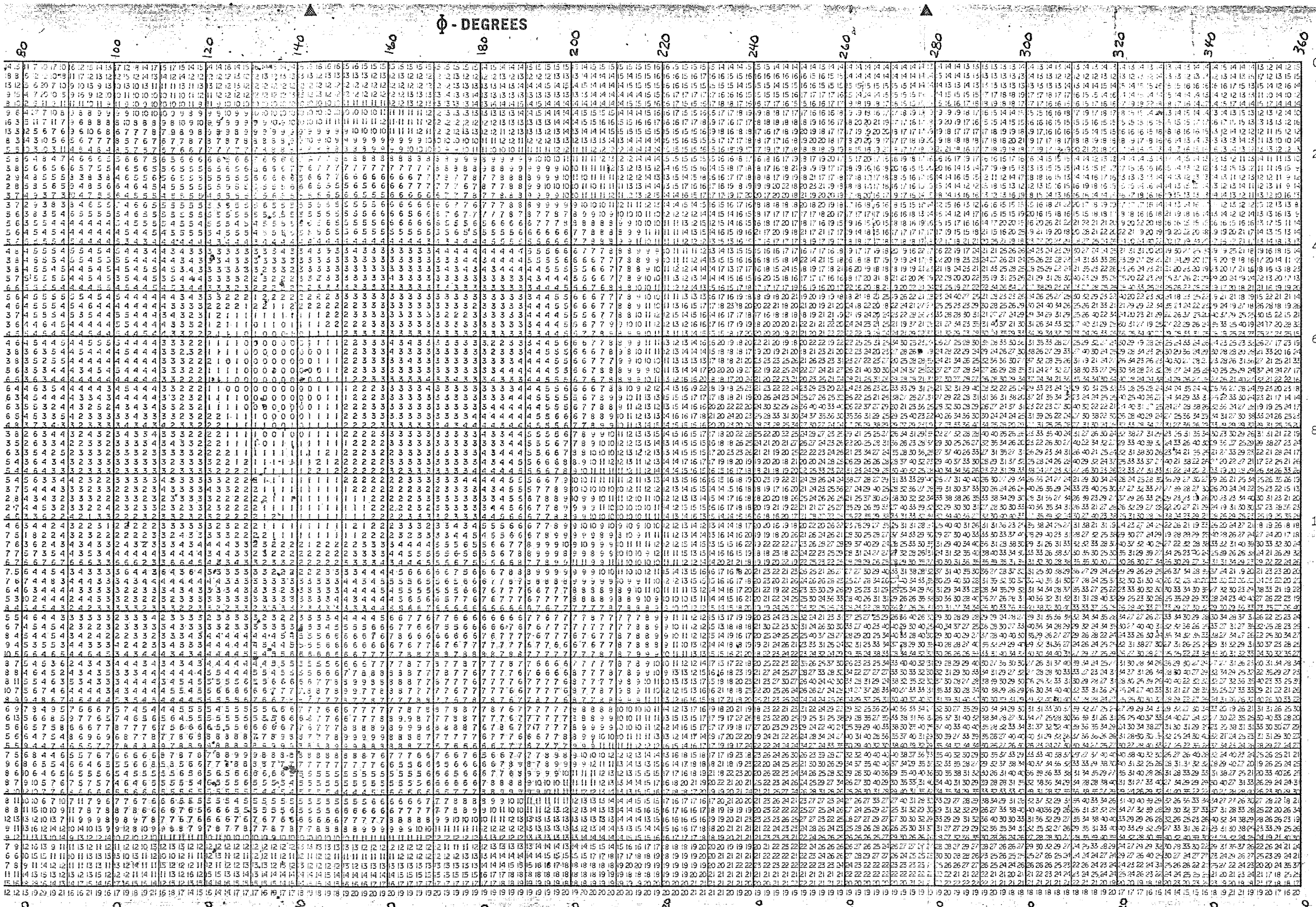
TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

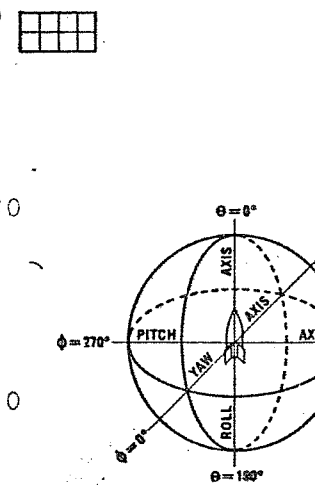
GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ, ☐ E_θ; CIRCULAR ☒ RH, ☐ LH

DATE: 10/21/66 PATTERN NO: 20 ORGANIZATION: IESD-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. L. LINDSEY

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ 5.7 −☐ DB RELATIVE TO AN ISOTROPIC ANTE

2





PRELIMINARY

CHART NO. 147

REMARKS:

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

RUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

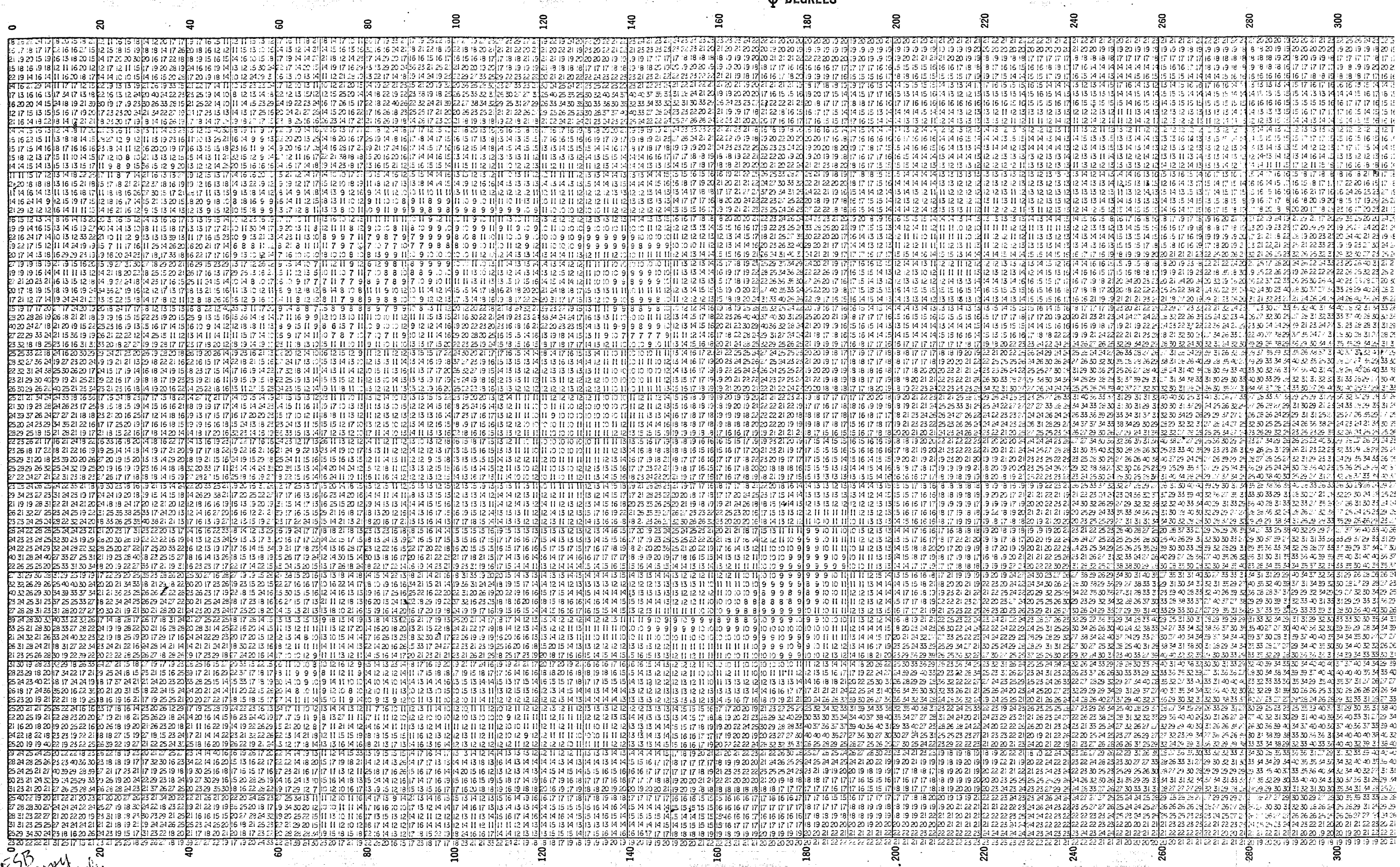
ESD-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

IN. FREQ. RANGE: S-BAND PATTERN MEASUREMENT FREQ: 2106 MHZ

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ −☐ 5.7 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION

PHASE-ANGLE PLOT: ☐ PHASE ANGLE RECORDED: ☐S ☐ S'



ESB copy only

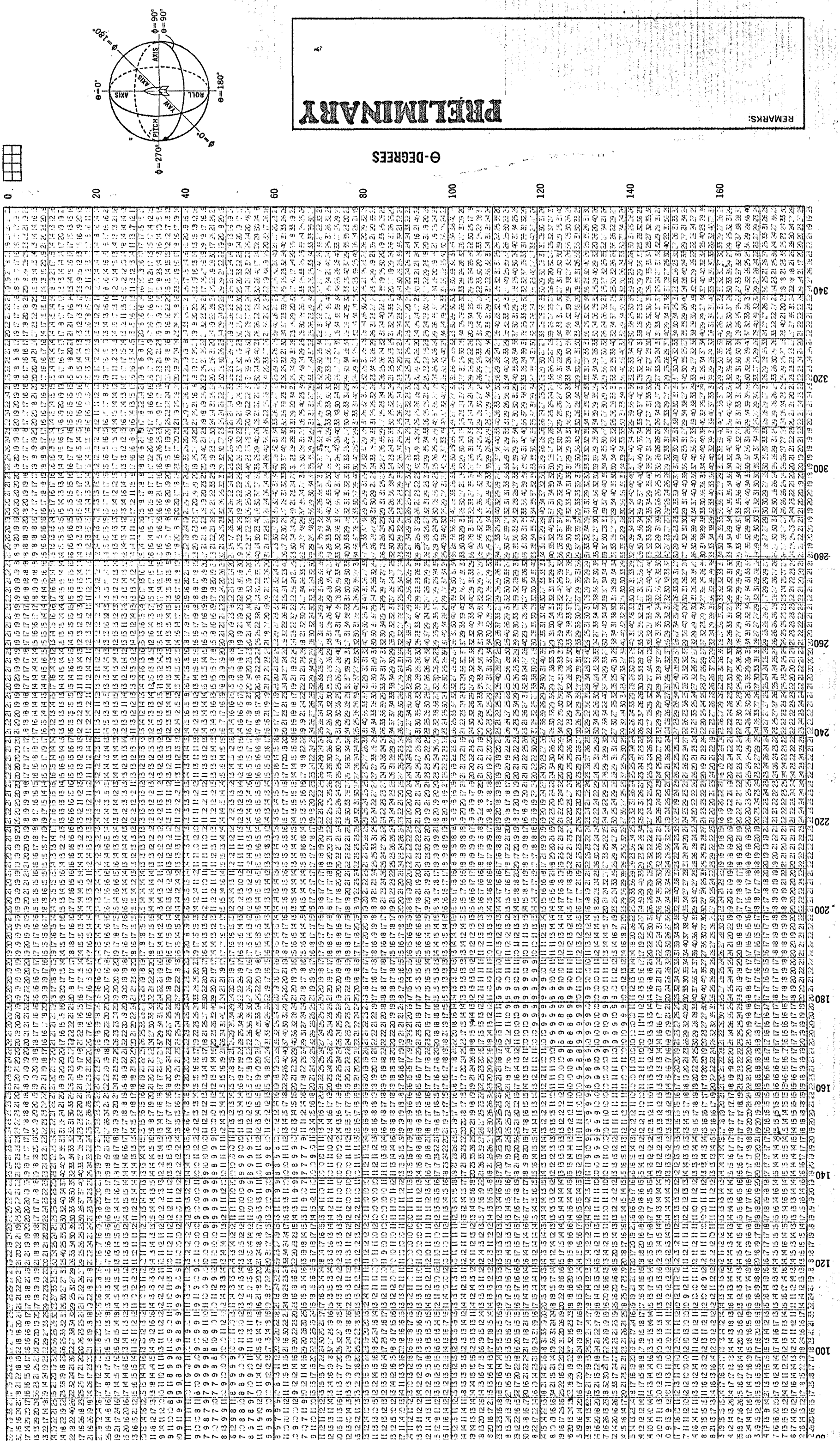
TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

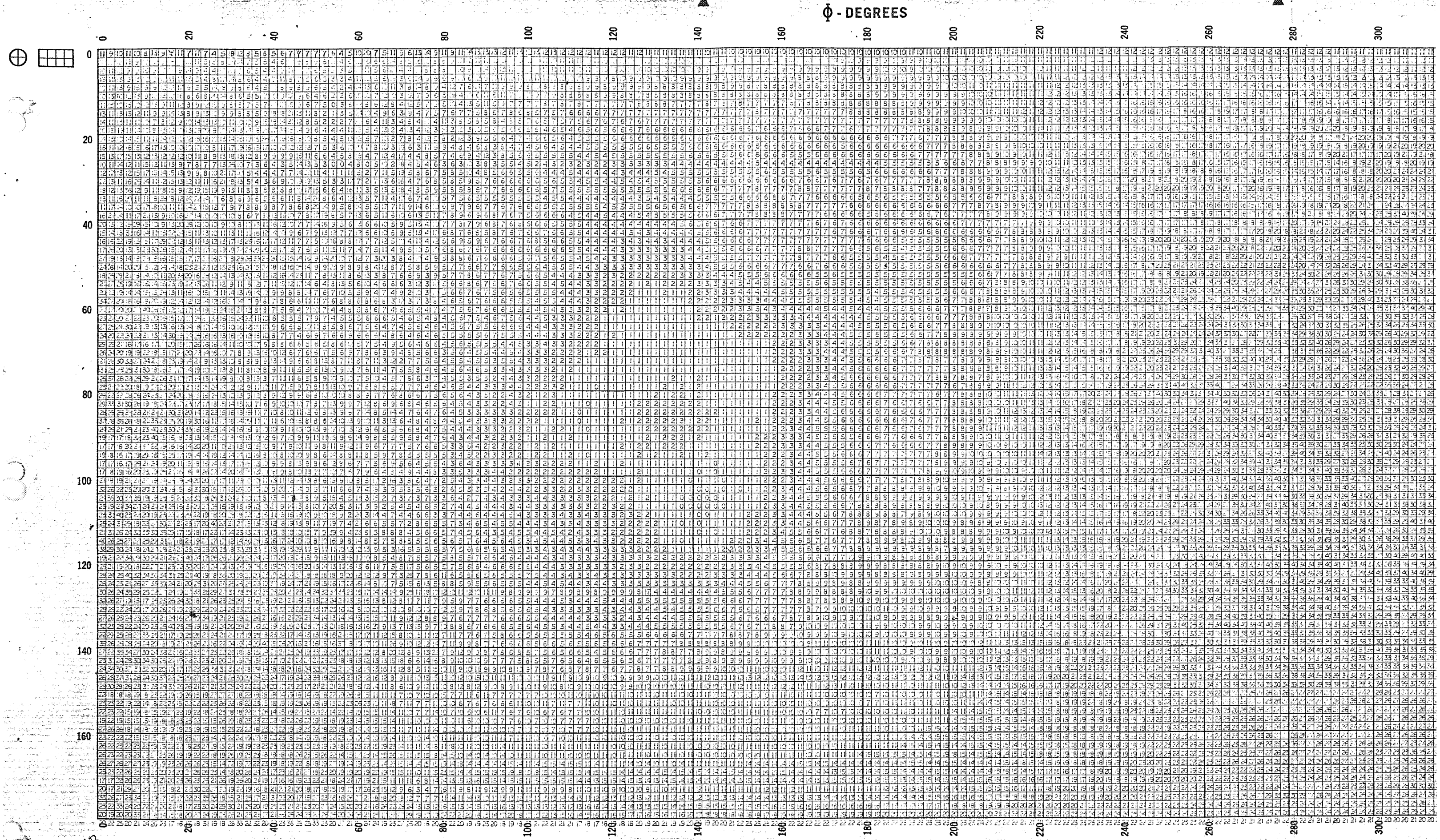
DATE: 10/22/66 PATTERN NO: 21 ORGANIZATION: IESD-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

ANTENNA TYPE: OMNI AT Φ=135

GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐Φ, ☐θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☒ 7.0 DB RELATIVE TO AN ISOTROPIC A


SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA
CHART NO. 148A
PRELIMINARY
REMARKS:
θ-DEGREES
Φ-DEGREES
ROLL
PITCH
YAW
AXIS
θ=0°
θ=180°
Φ=0°
Φ=180°
Φ=270°
Φ=90°
θ=90°
GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐Φ, ☐θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☒ 7.0 DB RELATIVE TO AN ISOTROPIC ANTENNA
PHASE ANGLE PLOT: ☐ PHASE ANGLE RECORDED: ☐ ☒ ☐
CIRCULAR POLARIZATION
MISSION: APOLLO
ENGRS: J. LINDSEY
PATTERN MEASUREMENT FREQ: 2.0 GHZ
FREQ RANGE: S-BAND
MSC ANTENNA RANGE
SYSTEMS SECTION
ANTENNA SYSTEM: MSC-ESB-ANTENNA



ESR

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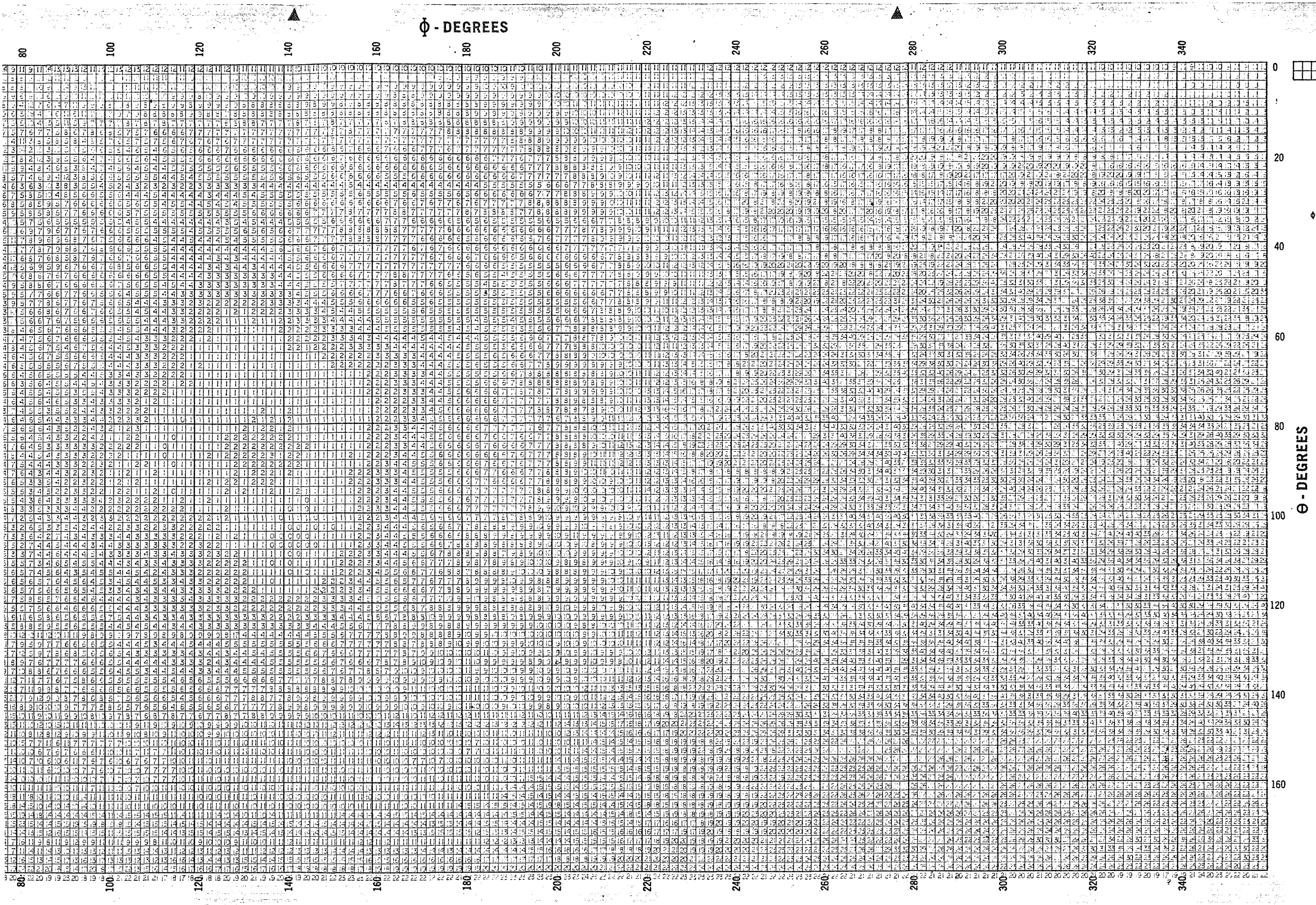
TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

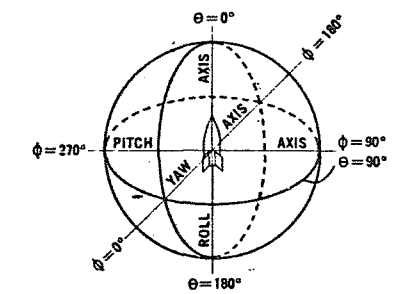
DATE: 10/26/66 PATTERN NO: 22 ORGANIZATION: LESD-ESR-ANTENNA SYTEMS SECTION ENGRS: J. LINDSEY

OMNI AT I 125 S BAND 2287MHZ

GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ 6.6 -☐ DB RELATIVE TO AN ISOTROPIC ANTENN





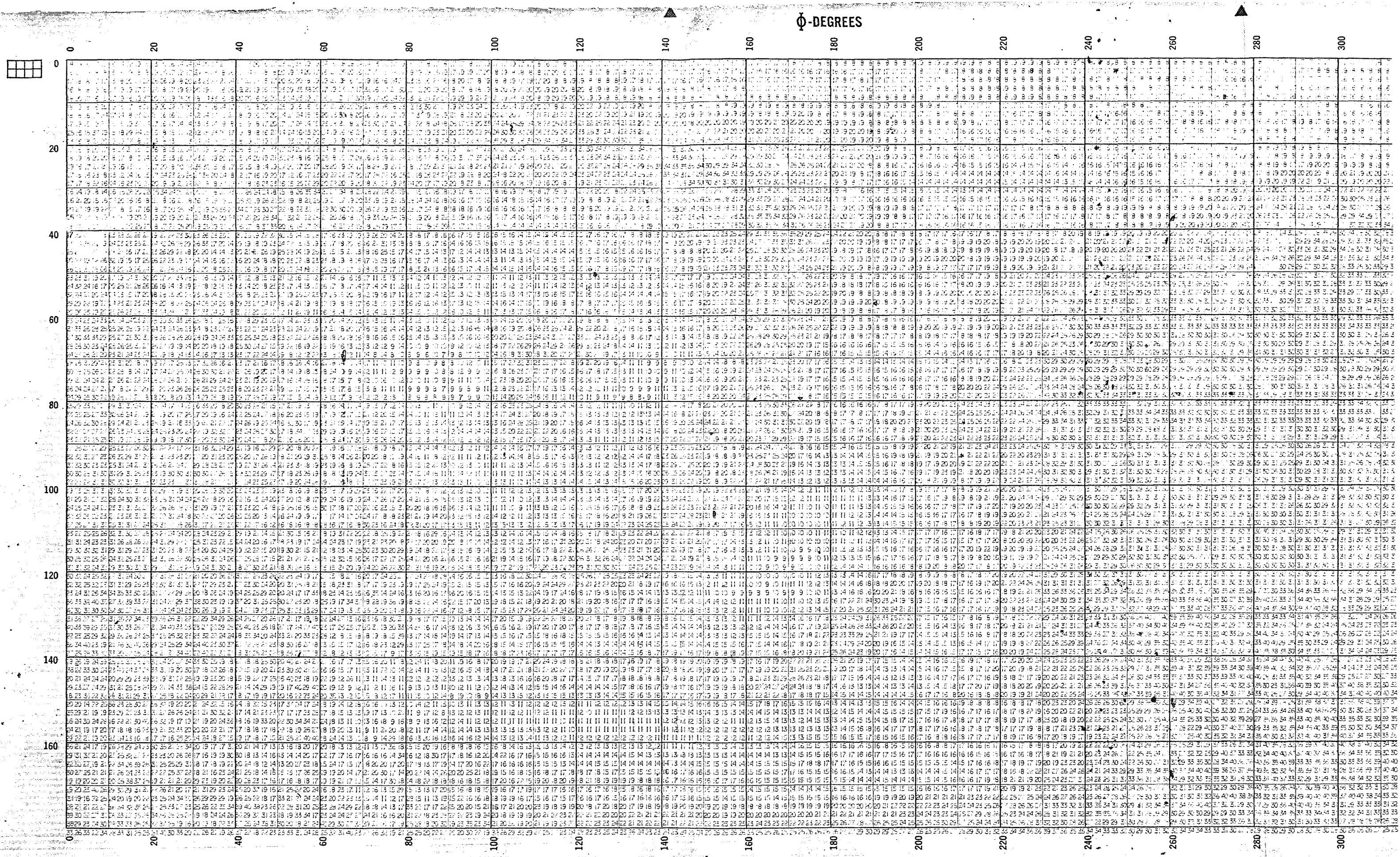
UMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

LESD-ESR-ANTENNA SYTEMS SECTION ENGRS: J. LINDSEY

FREQ. RANGE: S-BAND PATTERN MEASUREMENT FREQ. 2287 MHZ

GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_Φ, ☐ E_Θ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ -☐ 6.6 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

DATE: 9/28/66 PATTERN NO: 23 ORGANIZATION: MSD-MSB-ANTENNA SYSTEMS SECTION ENGRS: J. J. LINDSEY

ANTENNA TYPE: DUAL AT Φ = 135 FREQ RANGE: S-BAND

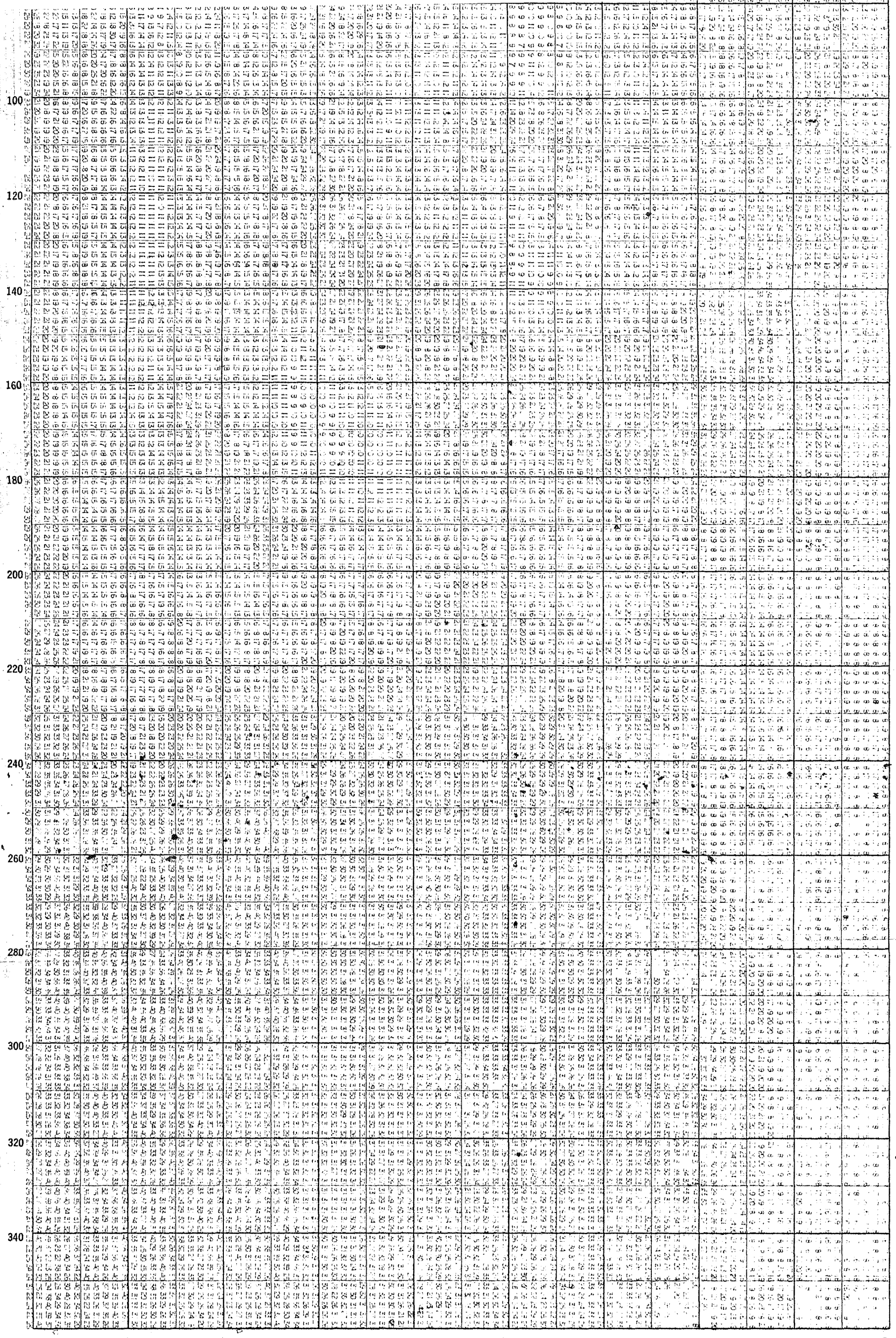
GAIN PLOT: ✕ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☐ − ☐ 6.6 DB RELATIVE TO AN ISOTROPIC A

ROTATION SYSTEM: MSC ANTENNA RANGE PROJECT: AFCRL

TSE-ANTENNA SYSTEMS SECTION ENGRS: L. LINDSEY

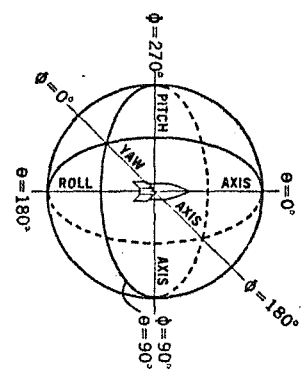
FREQ RANGE: S-BAND PATTERN MEASUREMENT FREQ: 2287 MHz



GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ Θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☐ 6.6 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION

PHASE ANGLE PLOT: ☐ ☐

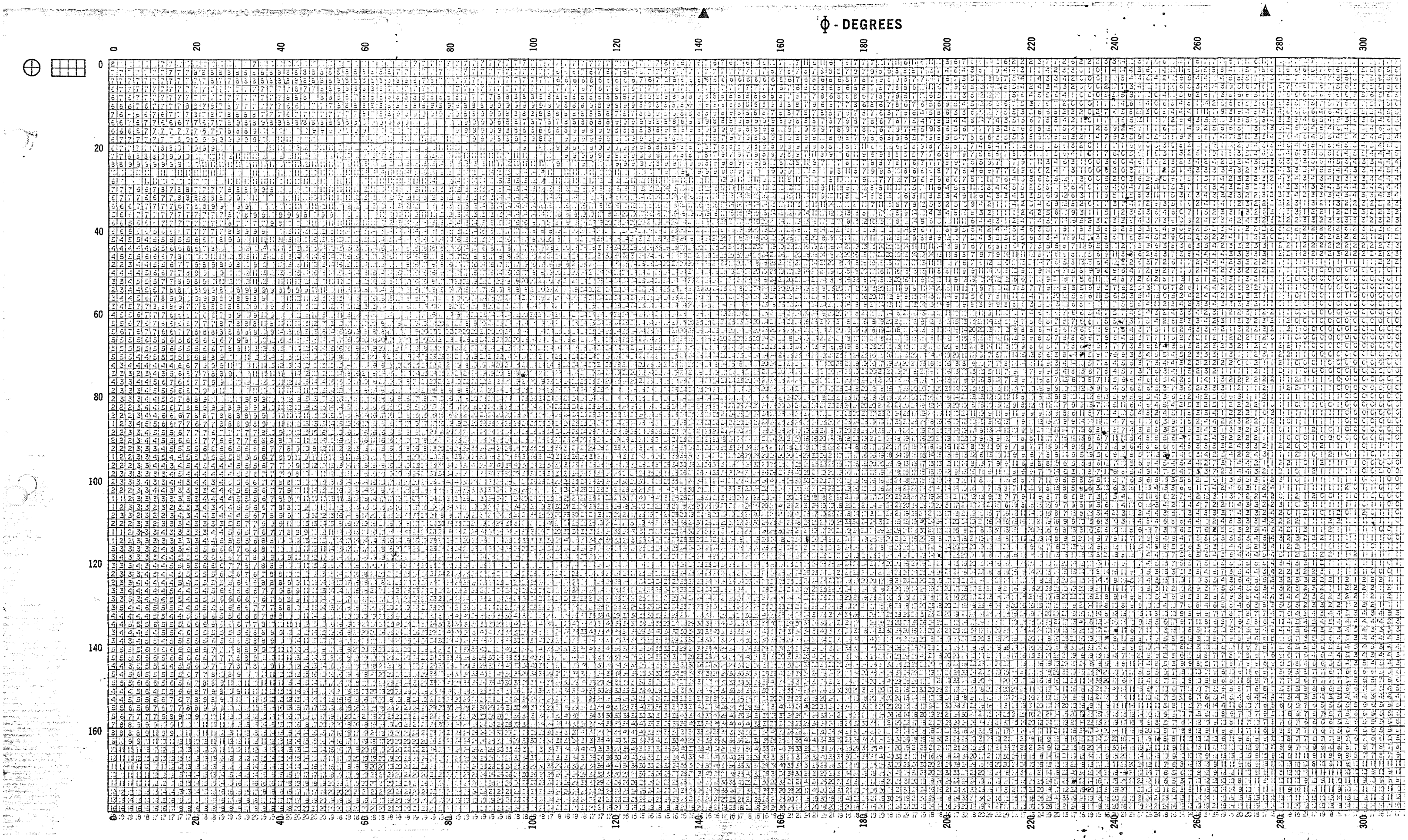


REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A



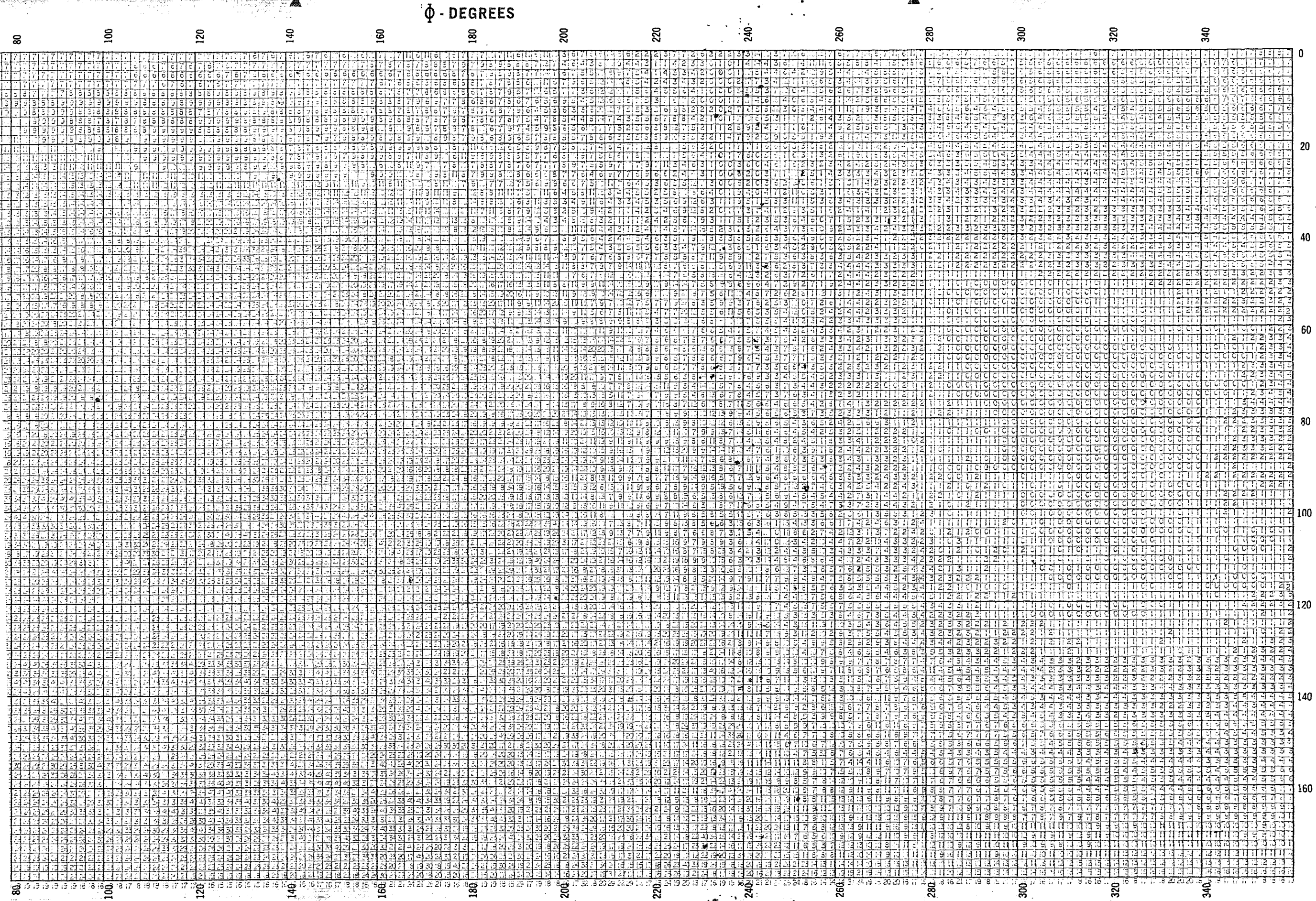
TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

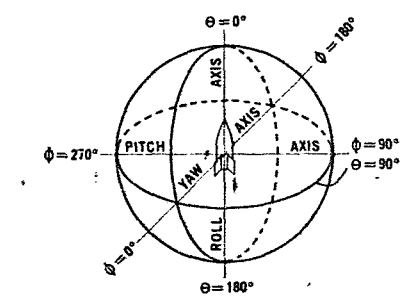
DATE: 3/4/65 PATTERN NO: 2 ORGANIZATION: MSC-ESE-ANTENNA SYSTEMS SECTION ENGRS: W. J. LINDSEY

ANTENNA TYPE: [illegible] AT 2.315 [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ, ☐ E_θ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ −☐ 4.1 DB RELATIVE TO AN ISOTROPIC ANTI





REMARKS:

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

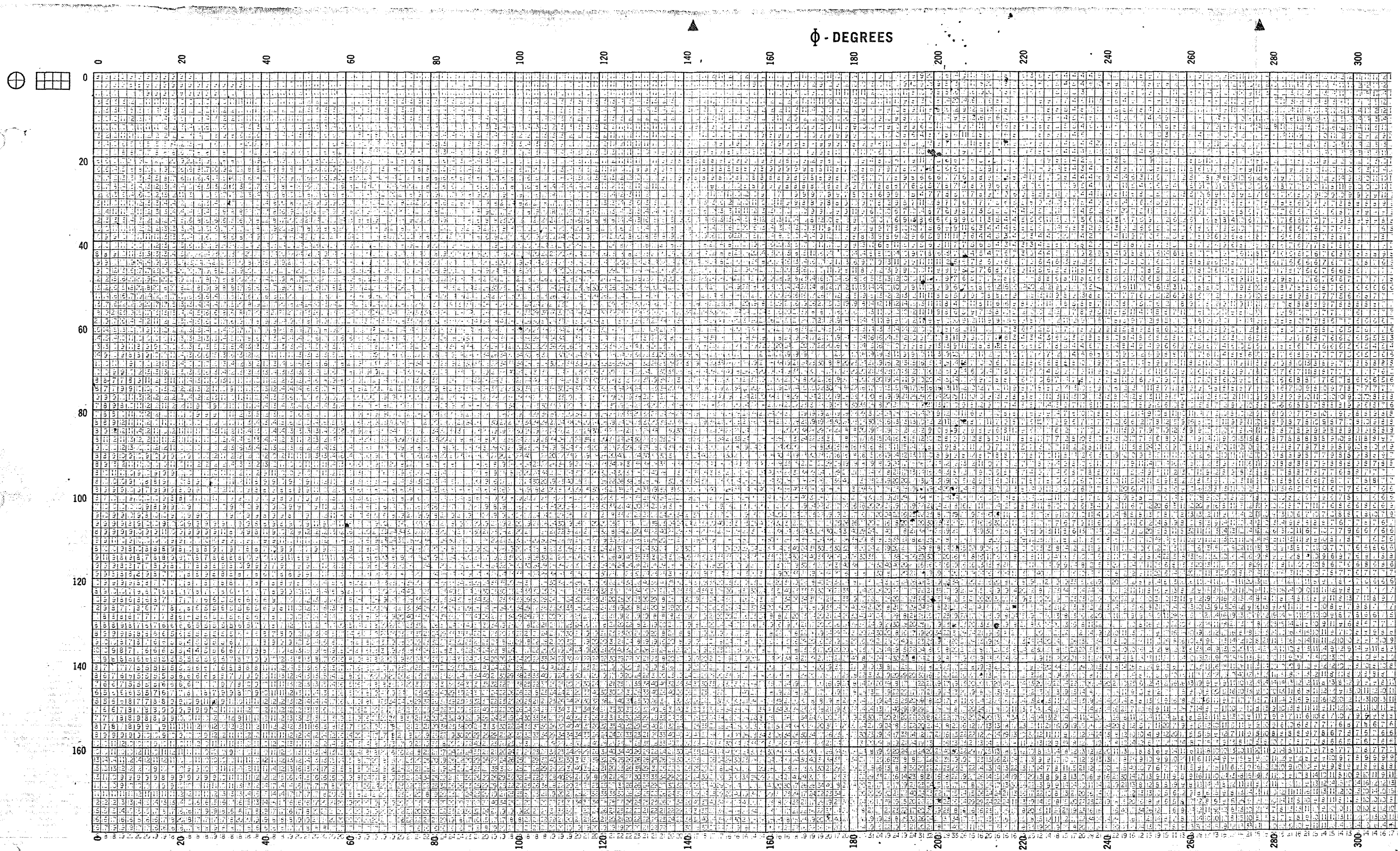
CHART NO. 145

ENTATION SYSTEM: USC ANTENNA RANGE PROJECT: APOLLO

SD-FSE-ANTENNA SYSTEMS SECTION ENGRS: J. L. LINDSEY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eϕ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ −☐ 4.1 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



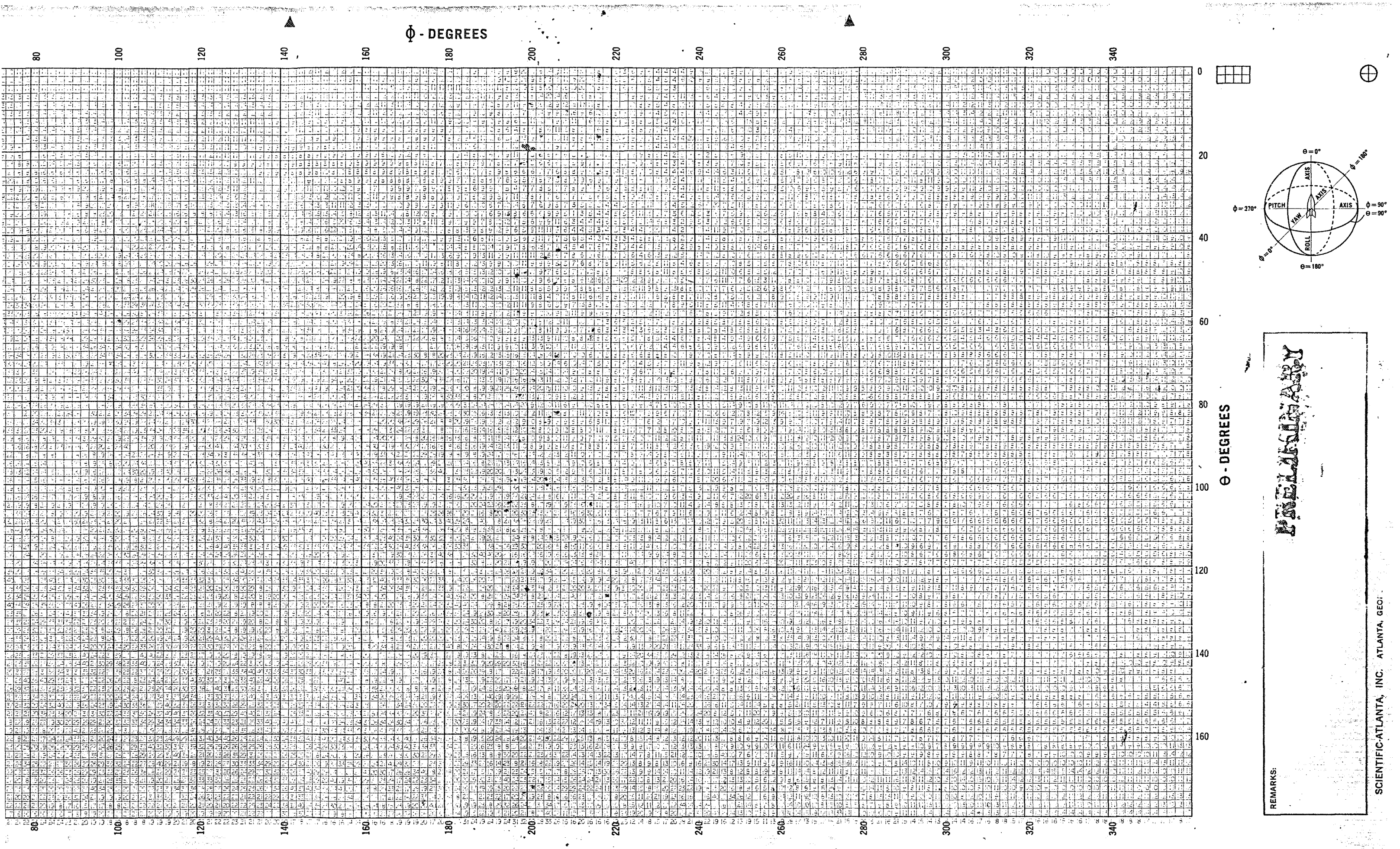
TEST PROGRAM OR VEHICLE: [illegible] INSTRUMENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: [illegible]

DATE: [illegible] PATTERN NO: 2E ORGANIZATION: [illegible] ANTENNA SYSTEMS SECTION ENGRS: [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ ☐ E_θ: CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ [illegible] DB RELATIVE TO AN ISOTROPIC ANT

2

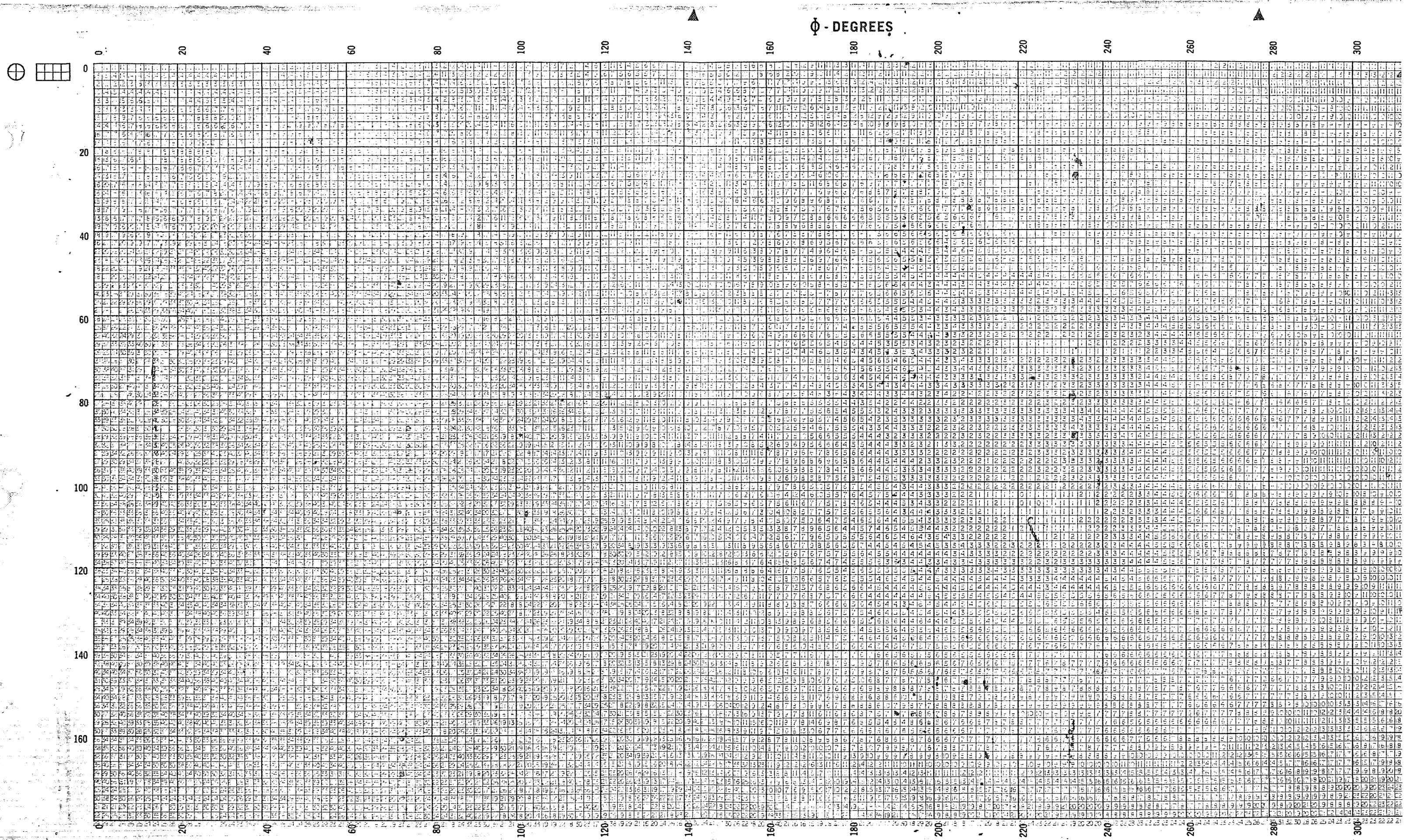


INSTRUMENTATION SYSTEM: NSO ANTENNA RANGE PROJECT: APOLLO

NASA-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eϕ, ☐ Eθ: CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ 4.1 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



TEST PROGRAM OR VEHICLE: [illegible] INSTRUMENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: APOLLO

DATE: [illegible] PATTERN NO: 26 ORGANIZATION: [illegible]-ANTENNA SYSTEMS SECTION ENGRS: [illegible] LINDSEY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ, ☐ E_θ; CIRCULAR ☒ RH, ☐ LH

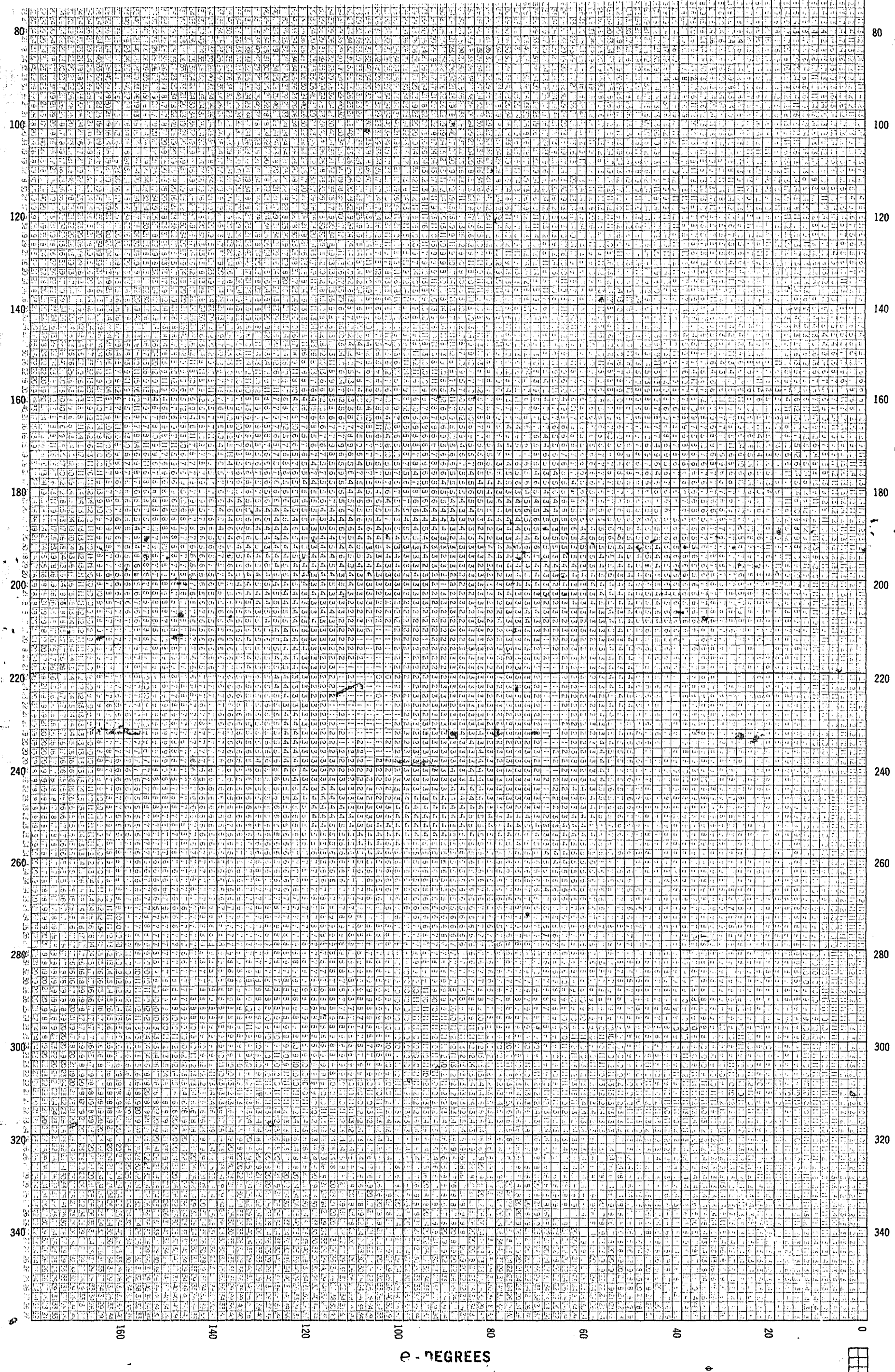
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ −☐ 6.7 DB RELATIVE TO AN ISOTROPIC ANTE

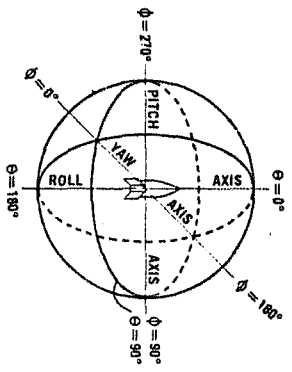
INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

LESD-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. L. INOSEY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ 6.7 ☐ DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



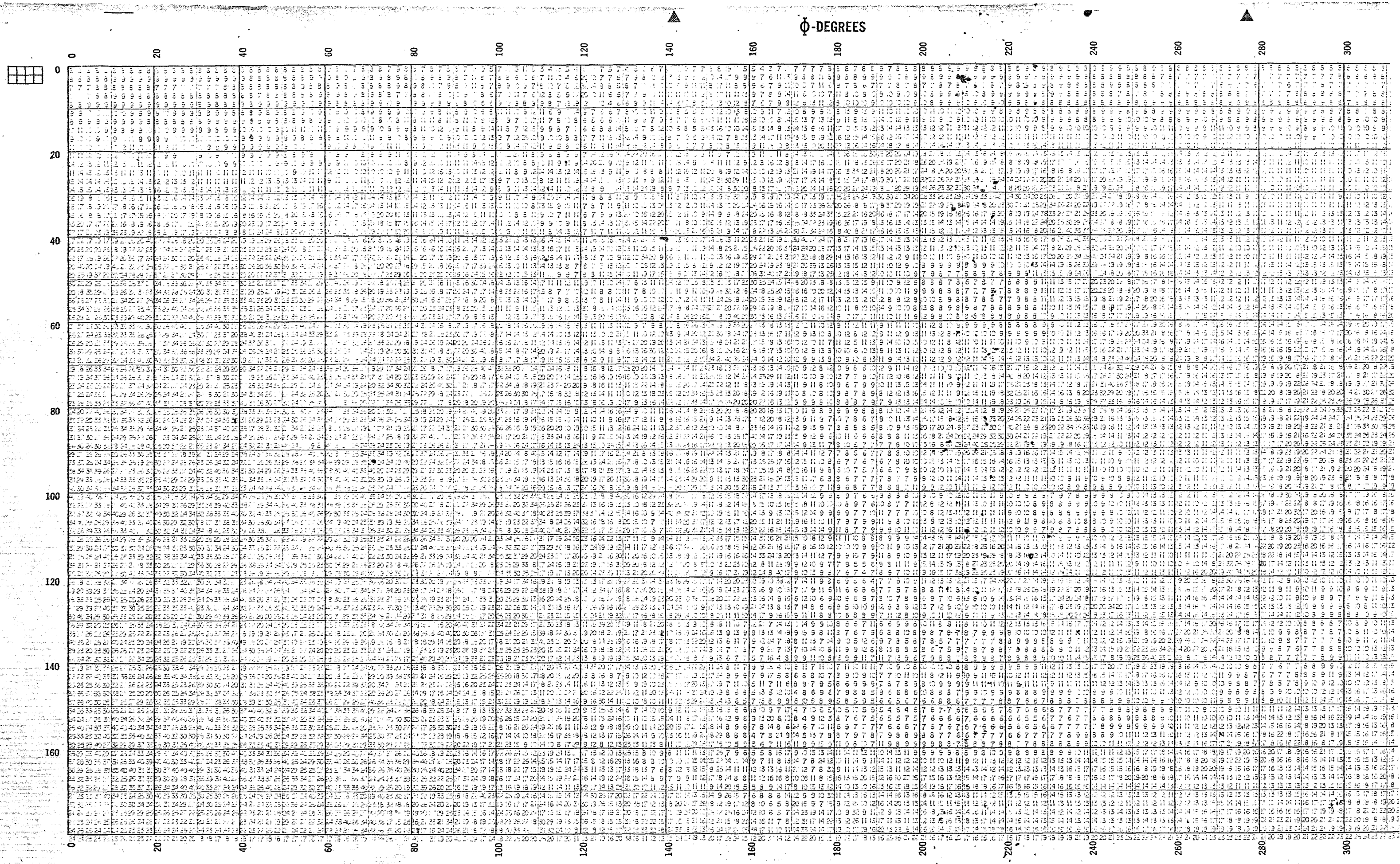


REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 145



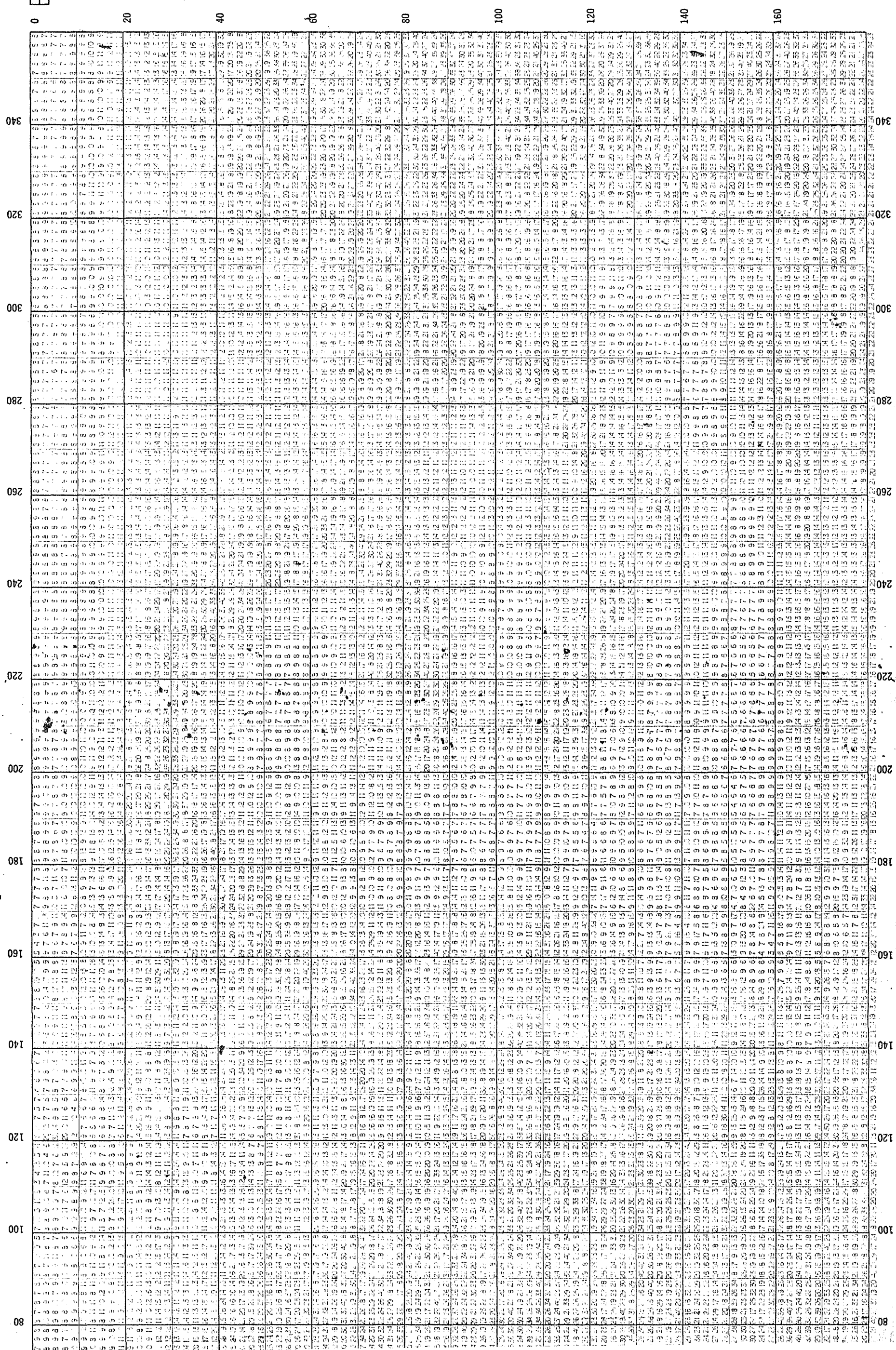
TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: USC ANTENNA RANGE PROJECT: APOLLO

DATE: [illegible] PATTERN NO: 22 ORGANIZATION: [illegible]-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

ANTENNA TYPE: [illegible] θ=22.5 [illegible] FREQ RANGE: [illegible]-BAND [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☒ 5.0 DB RELATIVE TO AN ISOTROPIC



REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

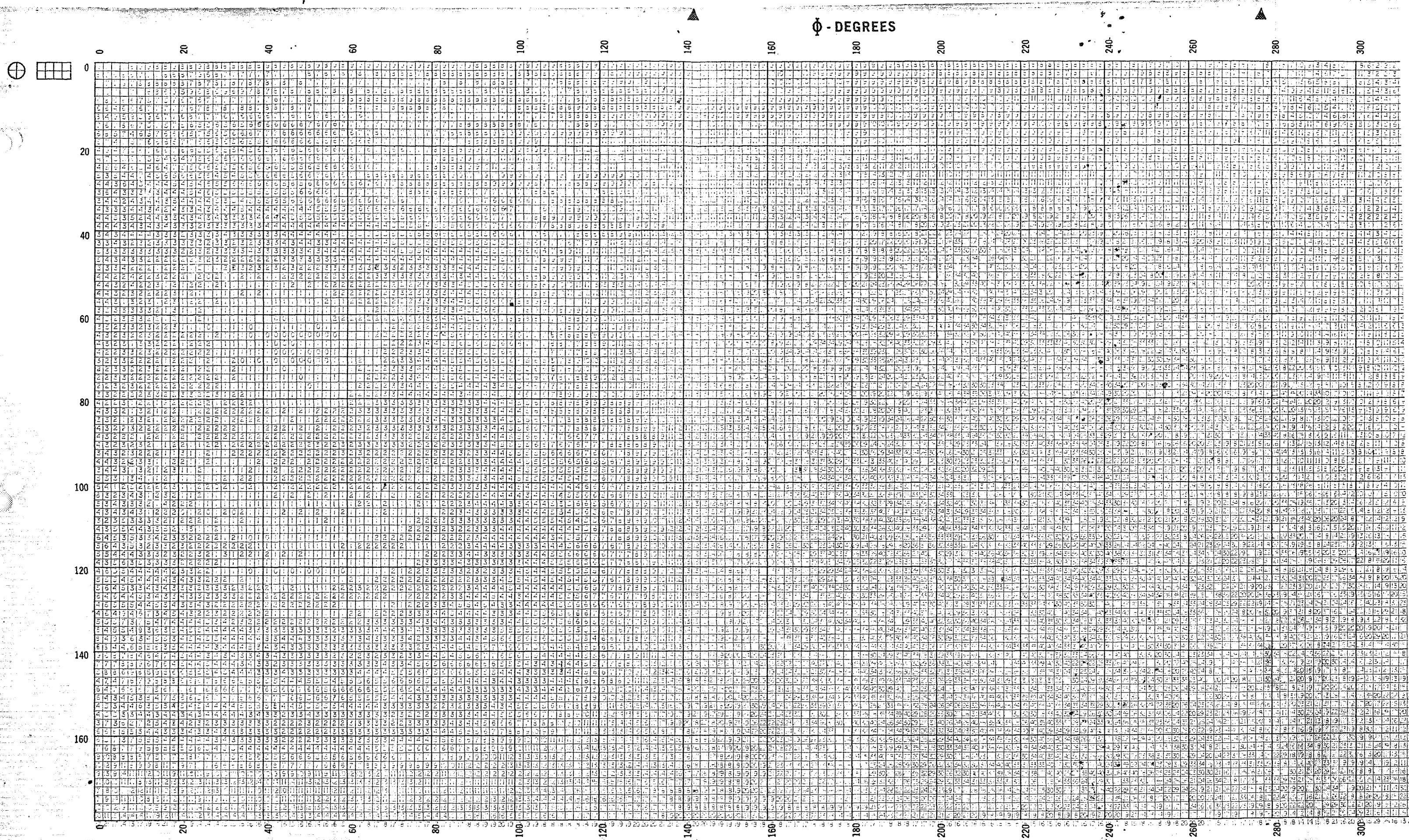
CHART NO. 148A

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☒ 5.0 ☐ DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION

DOCUMENTATION SYSTEM: USC ANTENNA RANGE PROJECT: APOLLO

ISC-ESE-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY



TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: USB ANTENNA RANGE PROJECT: APOLLO

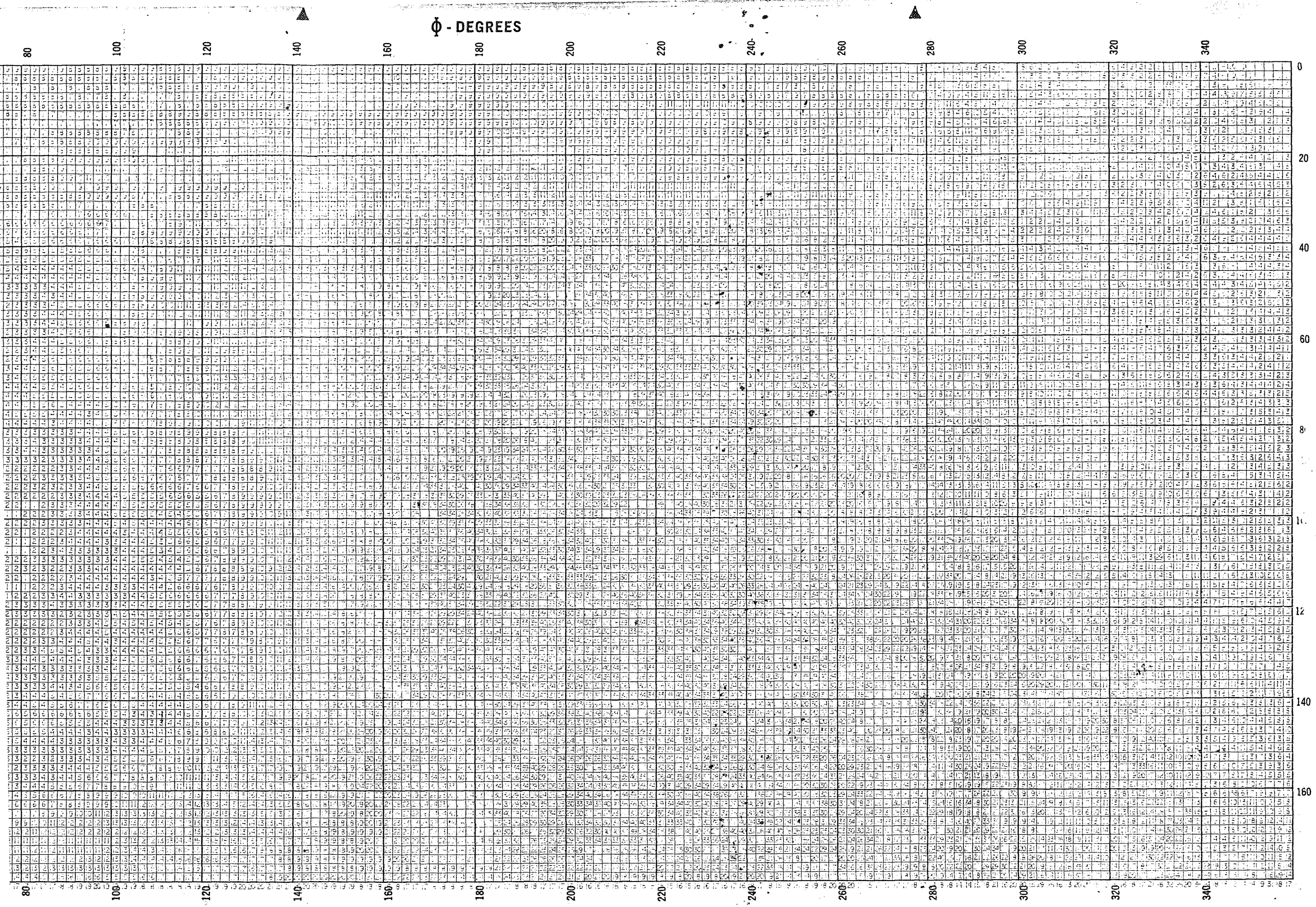
DATE: 3 FEB PATTERN NO: 28 ORGANIZATION: ENGRS: J. LINDSEY

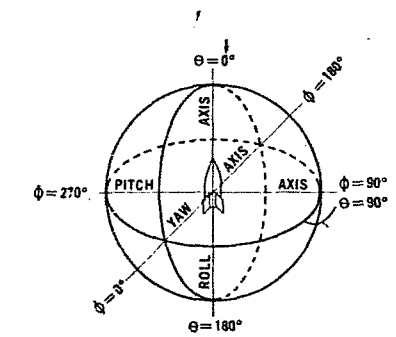
ANTENNA TYPE: δ=45 FREQ. RANGE: PATTERN MEASUREMENTS

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +Ø −□ 4.7 DB RELATIVE TO AN ISOTROPIC ANTE

2





REMARKS:

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

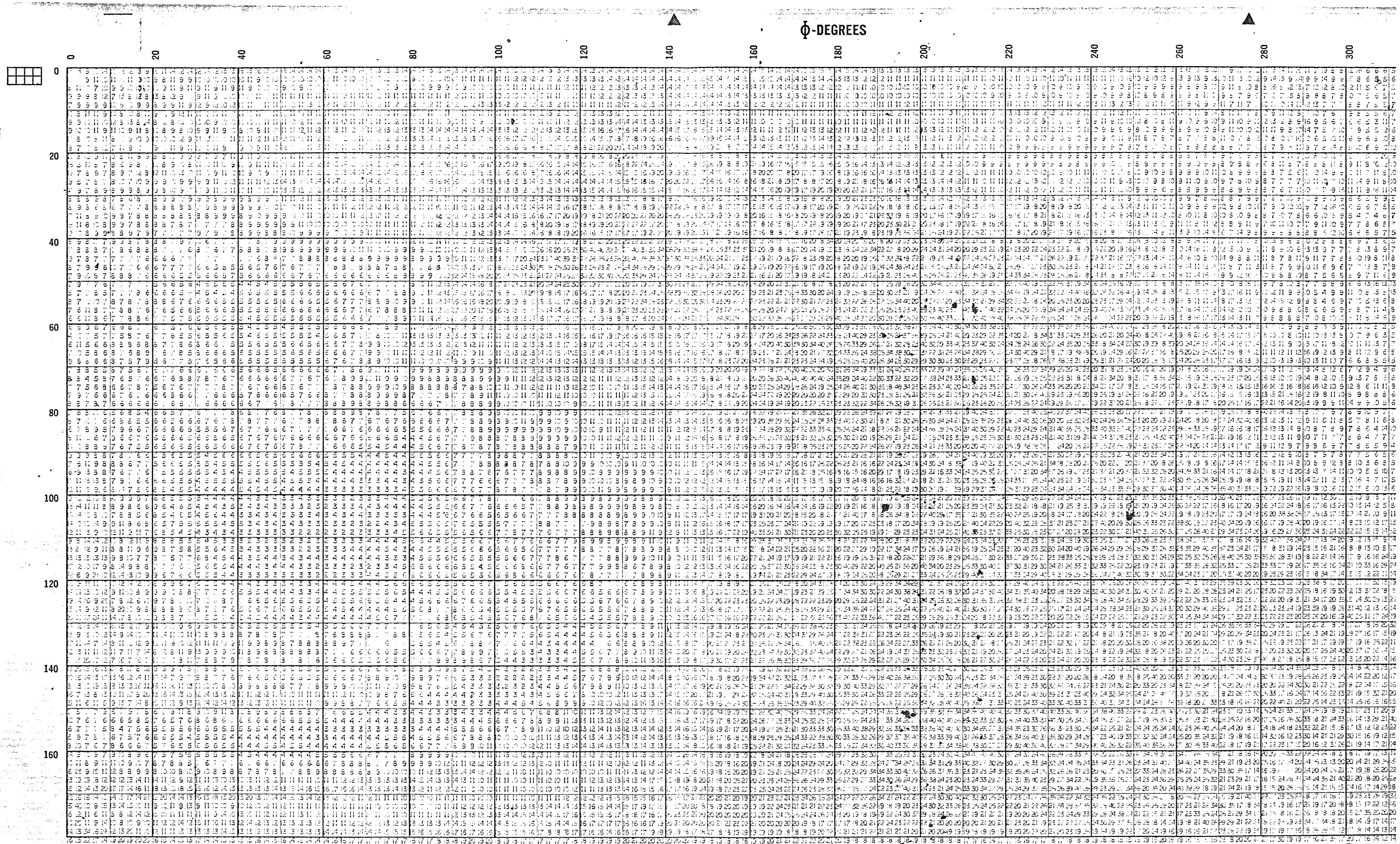
CHART NO. 143

JMENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: [illegible]

[illegible] ANTENNA ANALYSIS SECTION ENGRS: [illegible] INGSBY

GAIN PLOT: ■ POLARIZATION COMPONENT RECORDED: LINEAR □ E_ϕ, □ E_θ; CIRCULAR ☒ RH, □ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☒ −□ 4.7 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: USC ANTENNA RANGE PROJECT: APOLLO

DATE: 11/4/66 PATTERN NO: 22 ORGANIZATION: LESD-ESE: ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐Φ, ☐Θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☒ LH

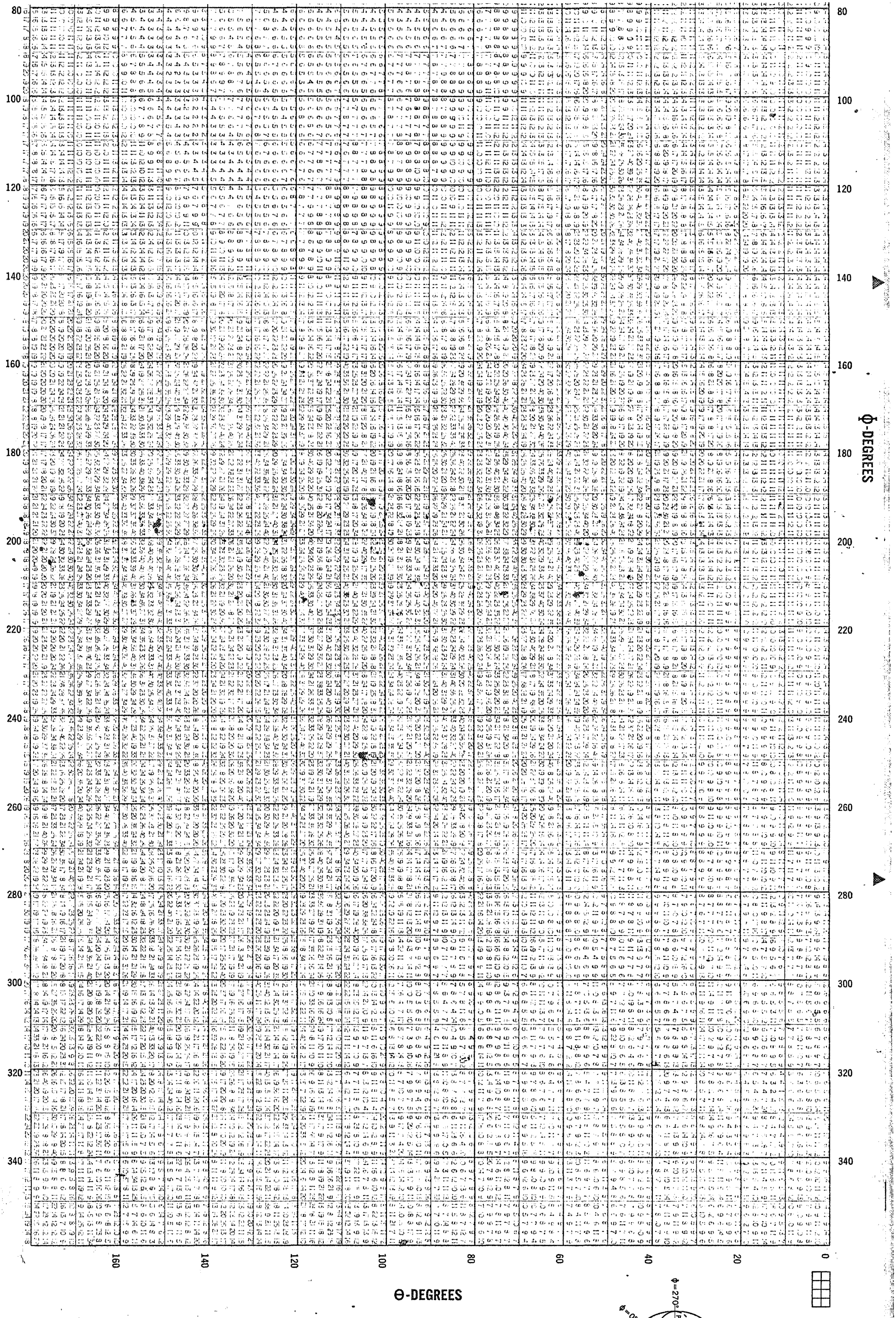
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF ± ☐ 3.7 DB RELATIVE TO AN ISOTROPIC

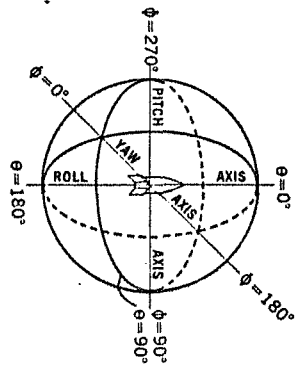
ENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: ABOL 2

SCIENTIFIC-ATLANTA SYSTEMS SECTION ENGRS: LINDSEY

GAIN-PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☐ 3.7 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



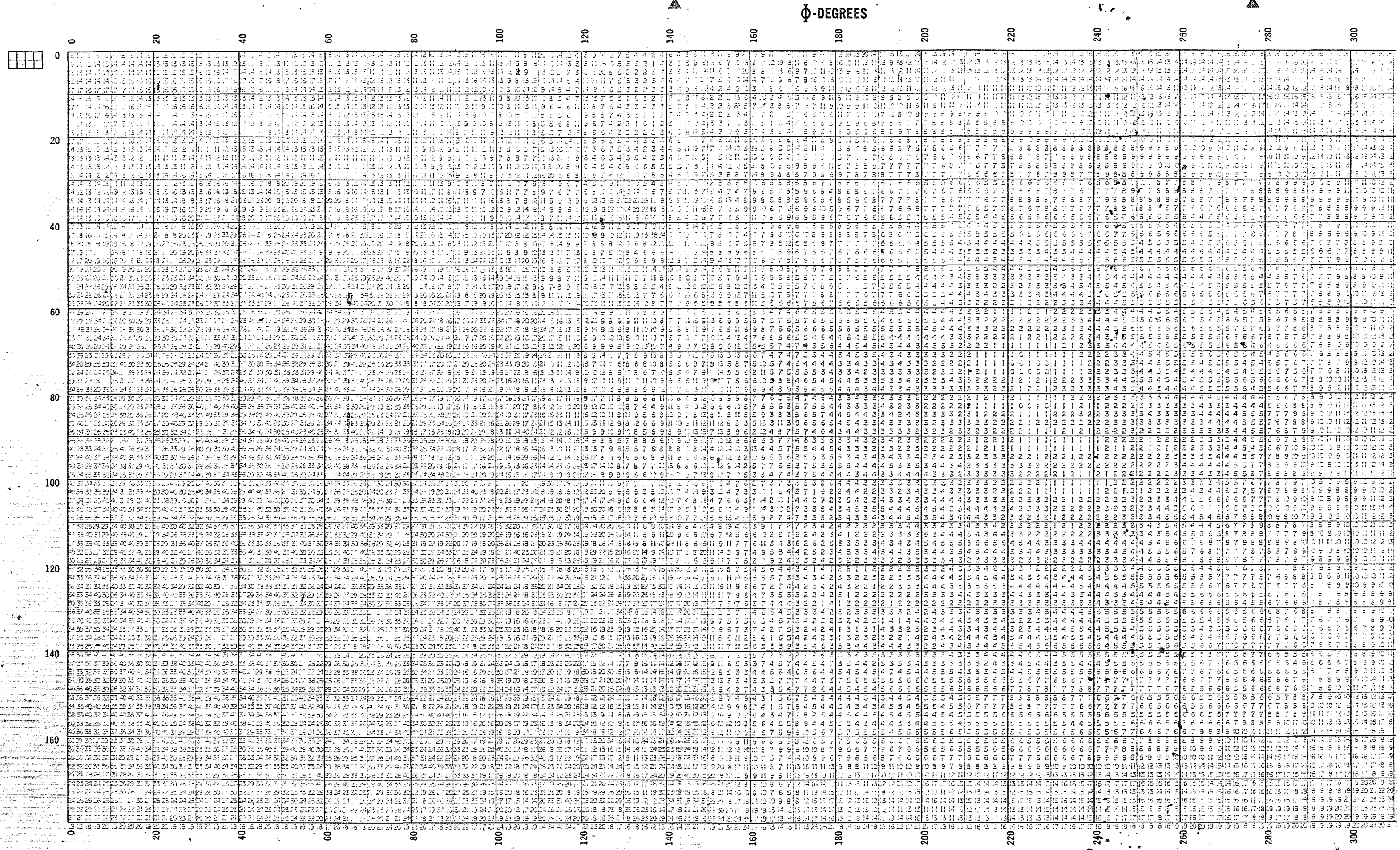


REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A

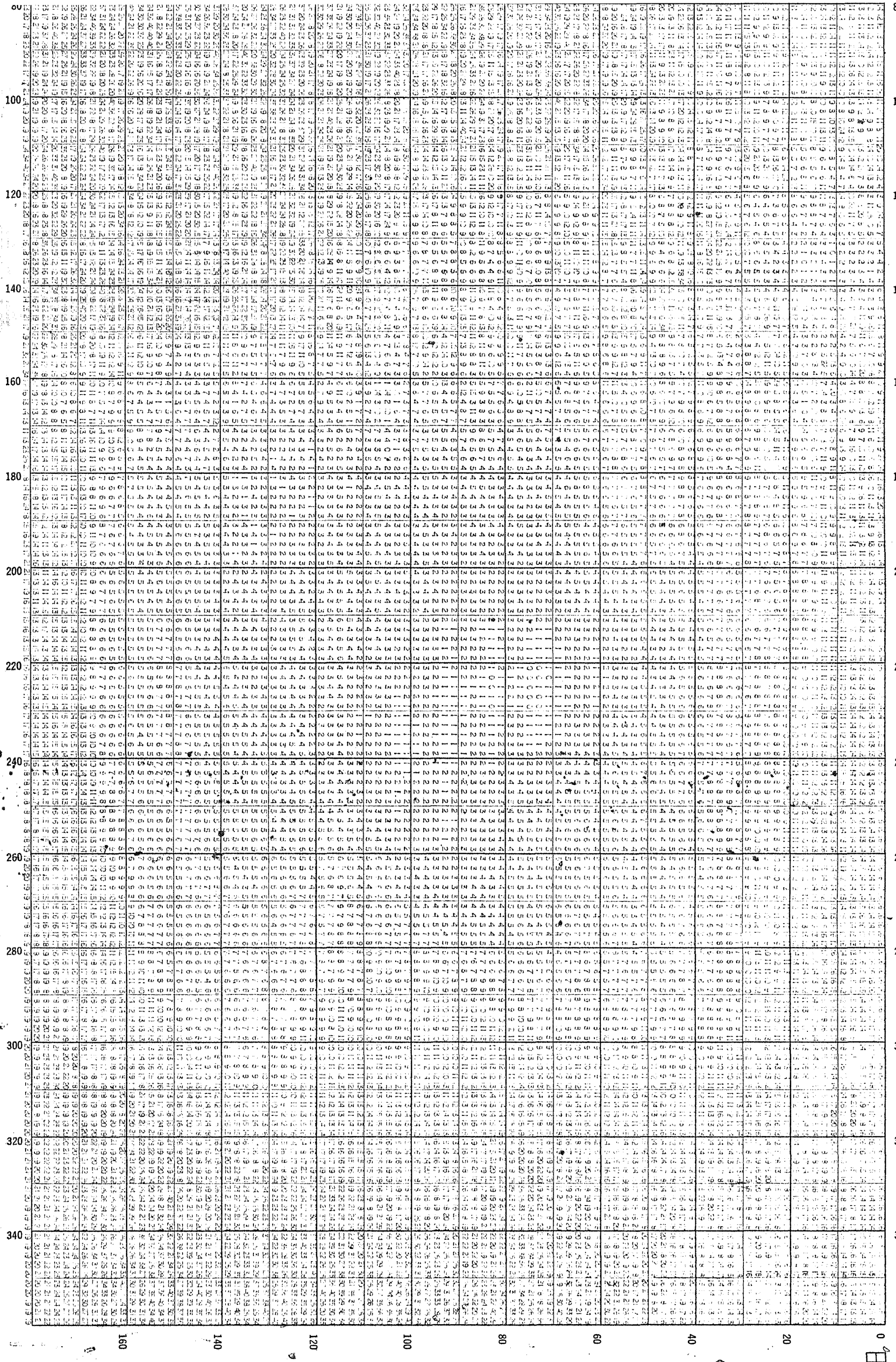


TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

GAIN PLOT: ✕ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

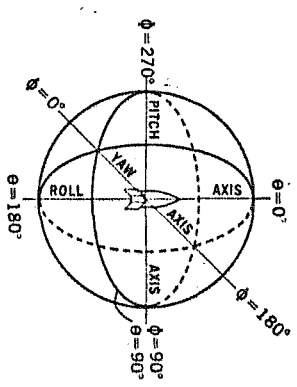
GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Φ, ☐ Θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

ORIENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO



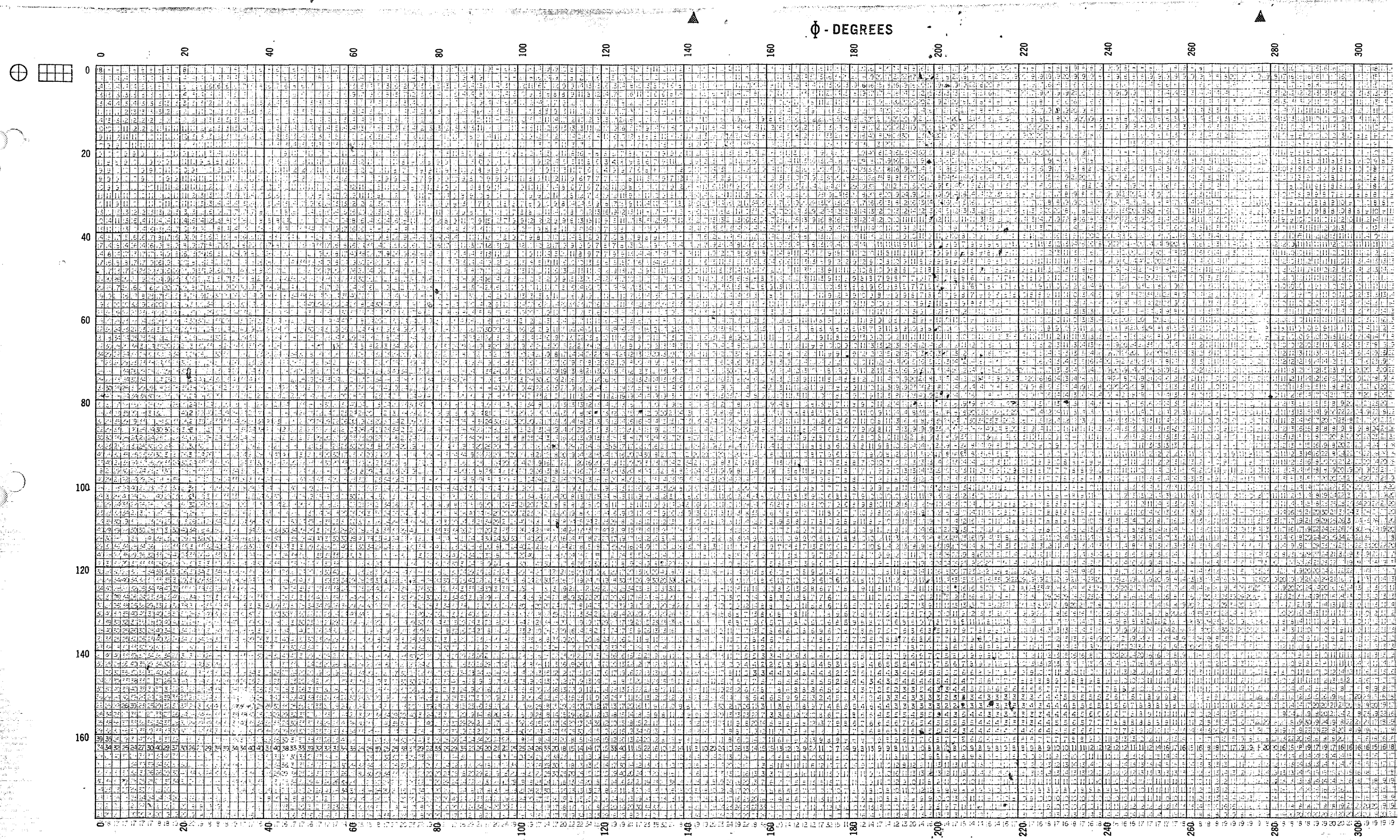
REMARKS:

PRELIMINARY



SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A

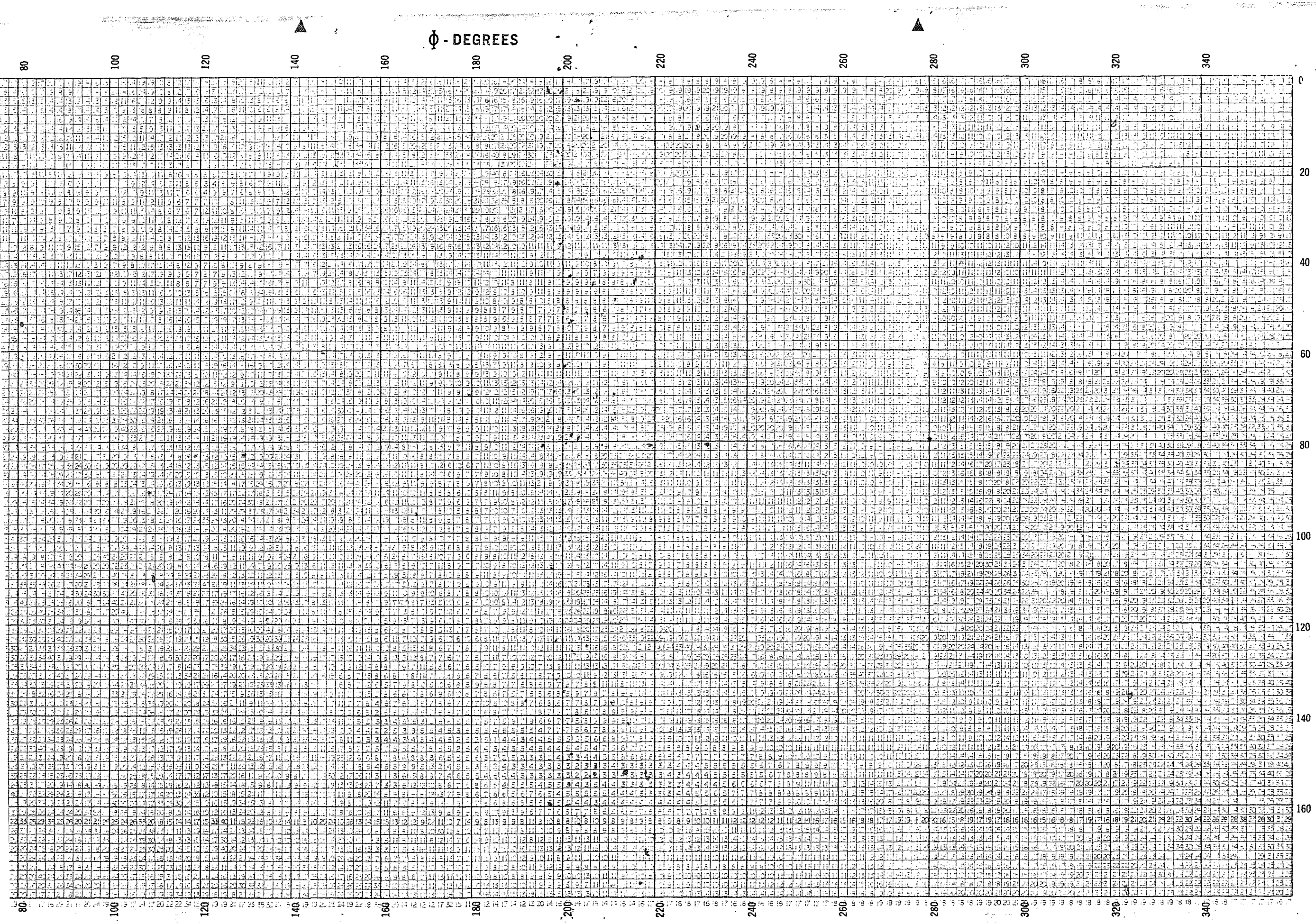


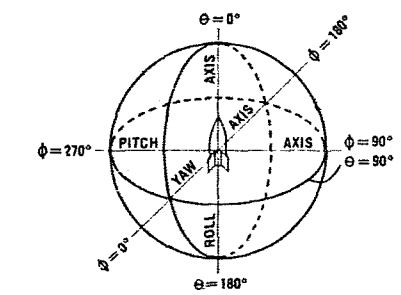
TEST PROGRAM OR VEHICLE: [illegible] INSTRUMENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: [illegible]

DATE: [illegible] PATTERN NO: [illegible] ORGANIZATION: [illegible] ANTENNA SYSTEMS SECTION ENGRS: [illegible]

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF ±☐ 5.6 DB RELATIVE TO AN ISOTROPIC ANT





PRELIMINARY

REMARKS:

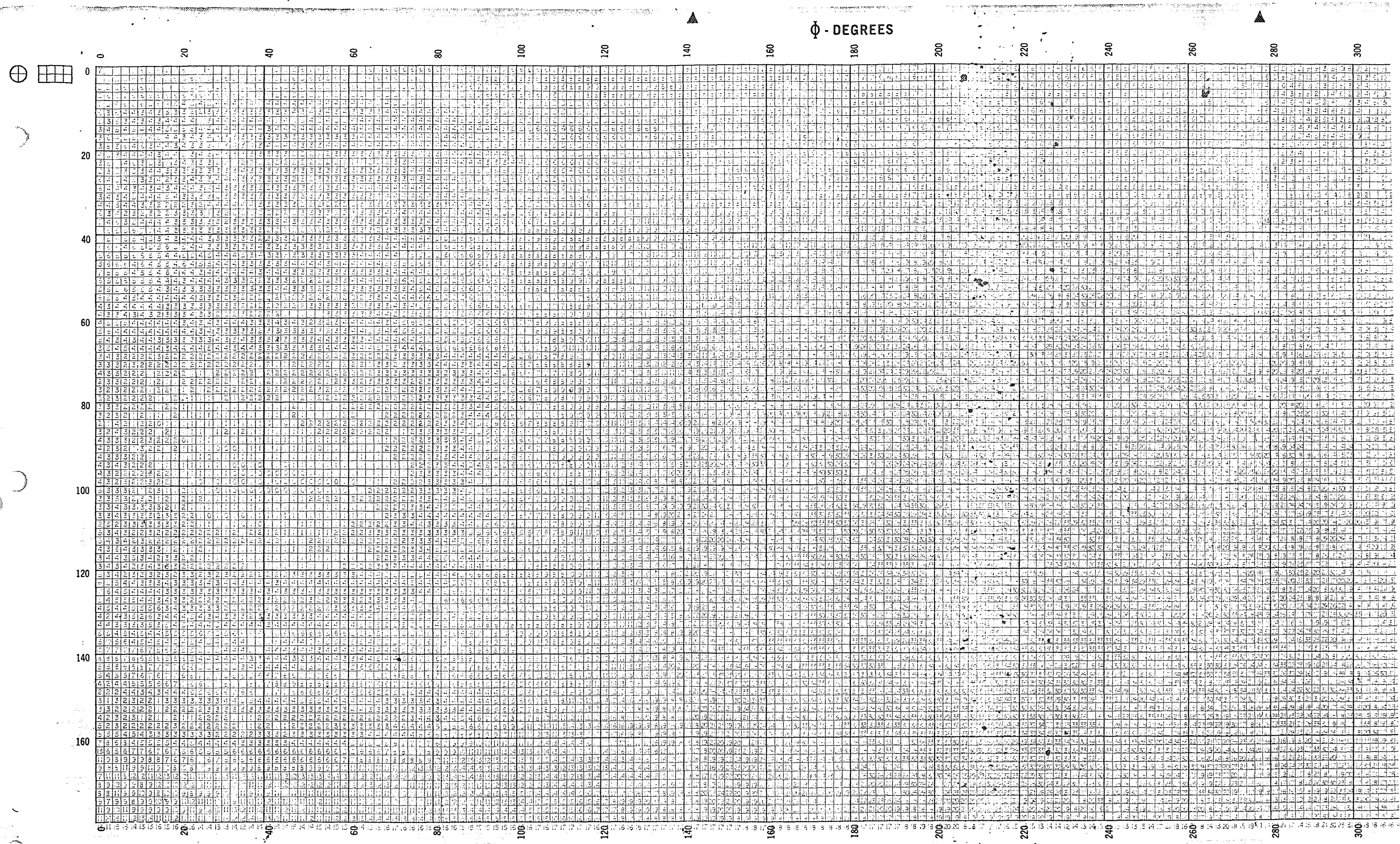
SCIENTIFIC-ATLANTA, INC.

MENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: [illegible]

[illegible]-FSR-ANTENNA SYSTEMS SECTION ENGRS: [illegible] INGSBY

GAIN PLOT: ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☐ RH, ☒ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ ☐- 5.6 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION



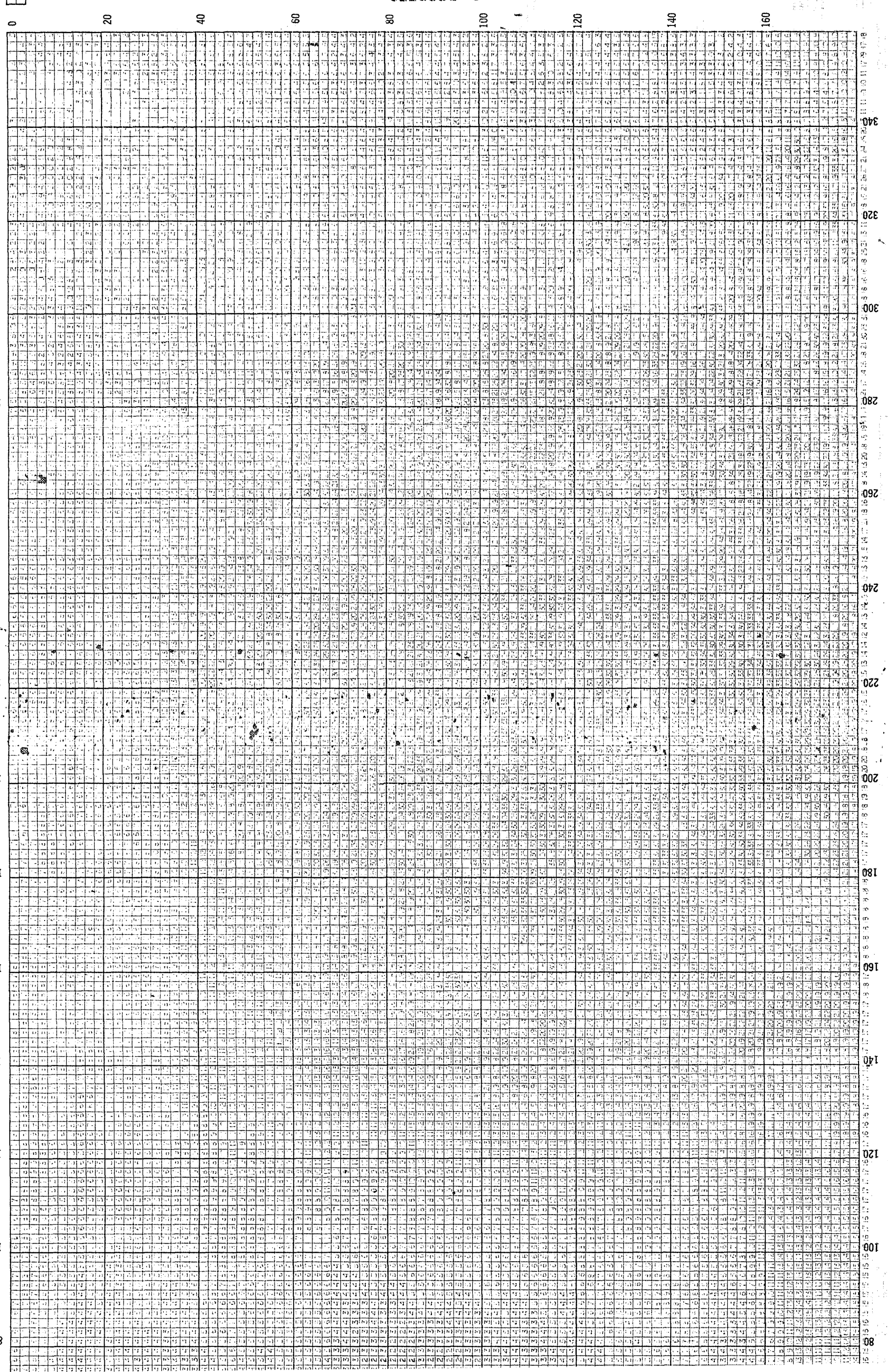
TEST PROGRAM OR VEHICLE: [illegible] INSTRUMENTATION SYSTEM: [illegible] ANTENNA RANGE PROJECT: [illegible]

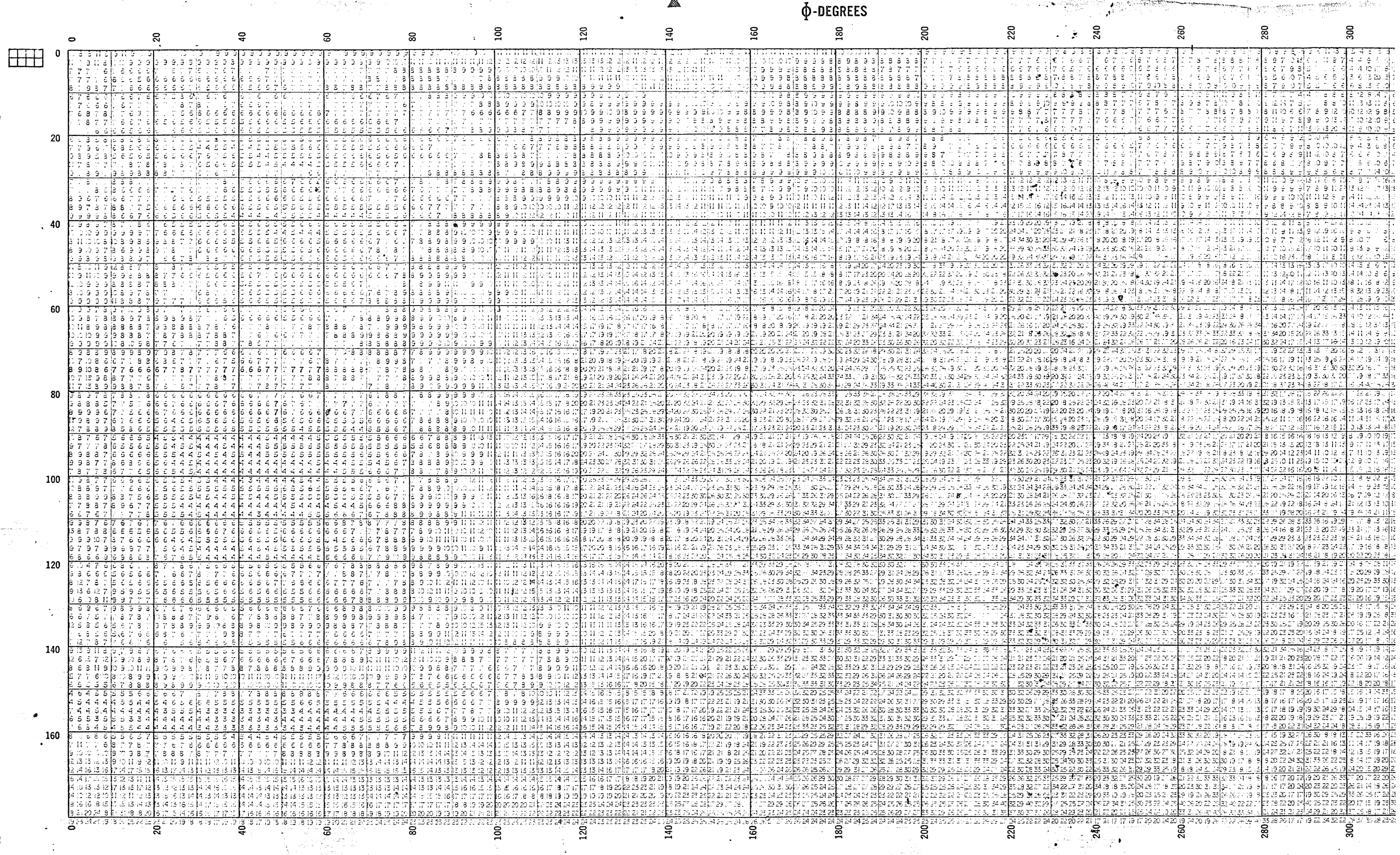
DATE: [illegible] PATTERN NO: 32 ORGANIZATION: [illegible] ANTENNA SYSTEMS SECTION ENGRS: [illegible]

ANTENNA TYPE: [illegible]

GAIN PLOT ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ, ☐ E_θ; CIRCULAR ☒ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☒ 5.1 DB RELATIVE TO AN ISOTROPIC ANT


SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA
CHART NO. 145
REMARKS:
PRELIMINARY
Θ - DEGREES
Φ - DEGREES
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
Φ = 270°
Φ = 90°
Θ = 90°
Θ = 0°
Θ = 180°
Φ = 0°
Φ = 180°
PITCH
ROLL
YAW
AXIS
GAIN PLOT ☒ POLARIZATION COMPONENT RECORDED: LINEAR ☐ EΦ, ☐ EΘ; CIRCULAR ☒ RH, ☐ LH
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☒ 5.1 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION
INSTRUMENTATION SYSTEM:
ENGRS:
PROJECT:



TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

DATE: 11-5-68 PATTERN NO: 33 ORGANIZATION: 1550-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

GAIN PLOT: ✕ POLARIZATION COMPONENT RECORDED: LINEAR □ϕ, □θ, □ 45, □ 135; CIRCULAR □ RH, □ LH

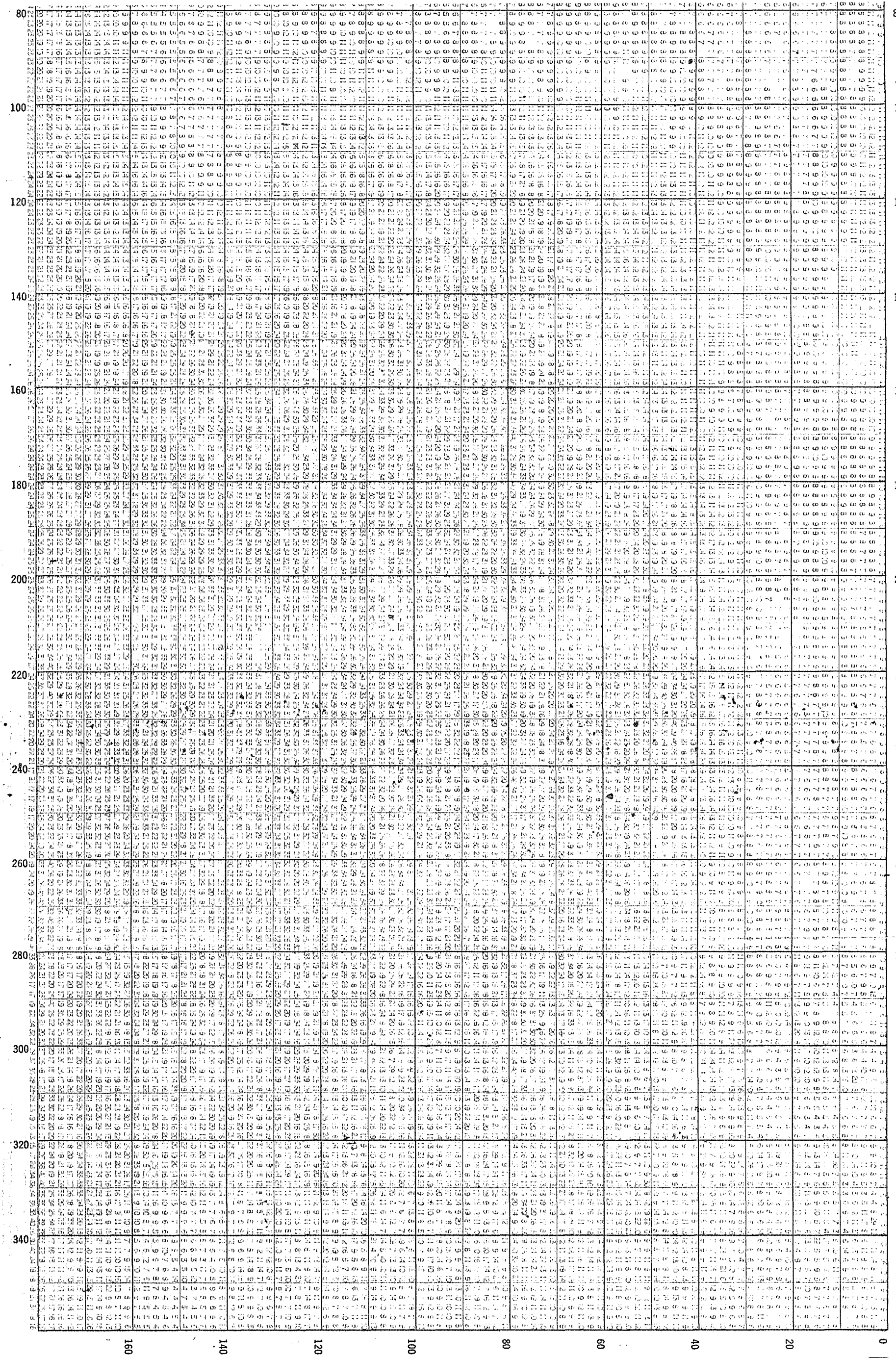
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + 5.1 DB RELATIVE TO AN ISOTROPIC

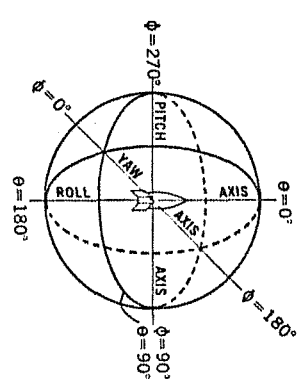
IENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

SOFTESS-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

GAIN PLOT: ☒ POLARIZATION-COMPONENT RECORDED: LINEAR ☐ φ, ☐ θ, ☐ 45, ☐ 135; CIRCULAR ☐ RH, ☐ LH

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF + ☐ 5.1 DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION





REMARKS:

PRELIMINARY

SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA

CHART NO. 148A

TEST PROGRAM OR VEHICLE: BLOCK II CSM INSTRUMENTATION SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO

GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐ E_ϕ, ☐ E_θ; CIRCULAR ☒ RH, ☐ LH

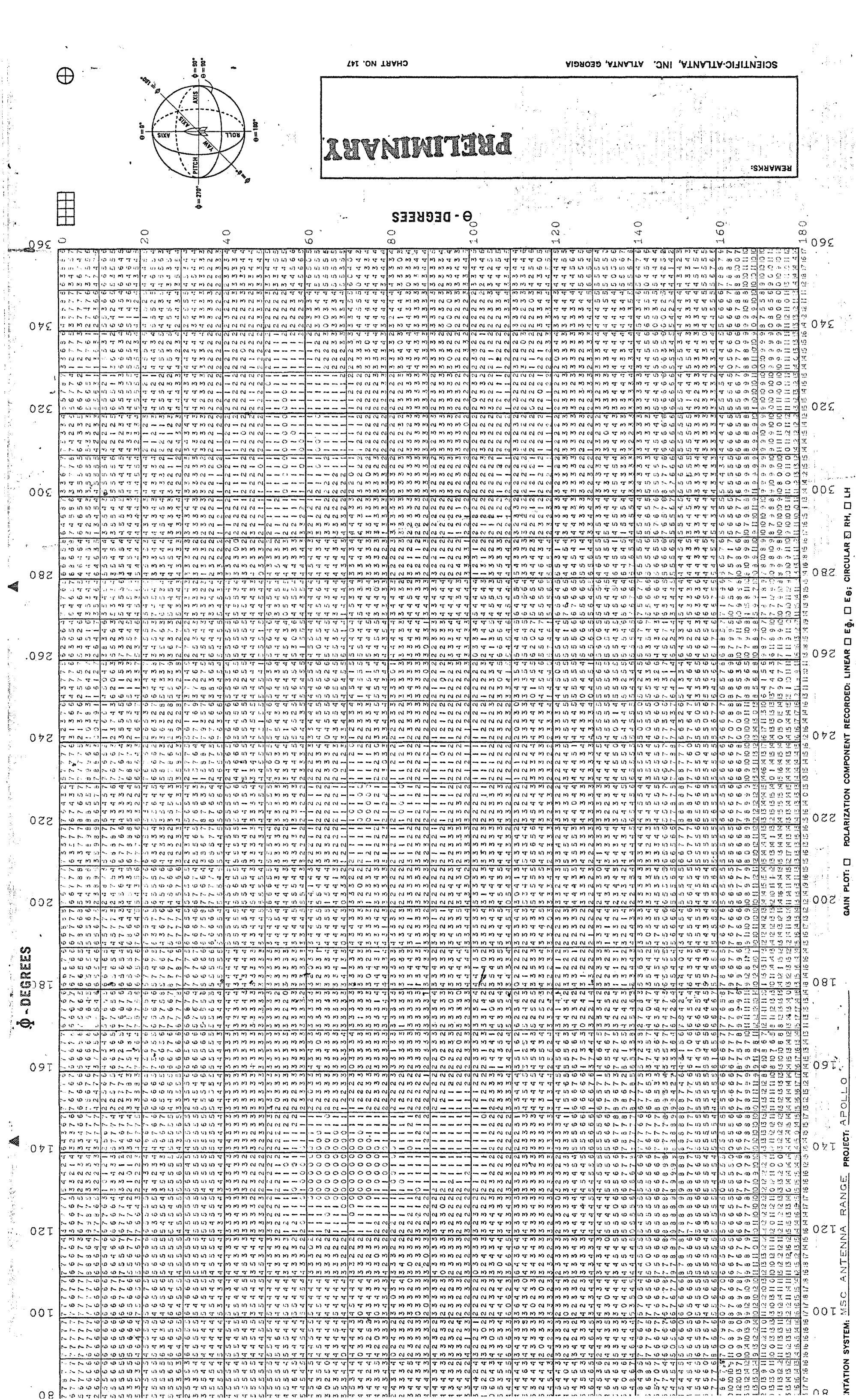
DATE: 12/19/66 PATTERN NO: B ORGANIZATION: TESD-ESB-ANTENNA SYSTEMS SECTION ENGRS: J. LINDSEY

GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ −☐ 6.0 DB RELATIVE TO AN ISOTROPIC ANTE

ANTENNA TYPE: OPTIMUM COMPOSITE FREQ. RANGE: S-BAND PATTERN MEASUREMENT FREQ. 2106MHZ

PHASE ANGLE PLOT: ☐ PHASE ANGLE RECORDED: ☐ °; ☐ %

K+E HERCULENE® 71296 DRAFTING FILM


SCIENTIFIC-ATLANTA, INC. ATLANTA, GEORGIA
CHART NO. 147
PRELIMINARY
REMARKS:
θ - DEGREES
φ - DEGREES
ROLL AXIS
YAW AXIS
PITCH AXIS
θ = 0°
θ = 180°
φ = 270°
φ = 90°
θ = 90°
φ = 180°
φ = 0°
GAIN PLOT: ☐ POLARIZATION COMPONENT RECORDED: LINEAR ☐ Eφ, ☐ Eθ; CIRCULAR ☒ RH, ☐ LH
GAINS ARE IN DECIBELS BELOW A REFERENCE LEVEL OF +☐ 6.0 ☐ DB RELATIVE TO AN ISOTROPIC ANTENNA OF CIRCULAR POLARIZATION
PHASE-ANGLE PLOT: ☐ PHASE ANGLE RECORDED: ☐ Eφ, ☐ Eθ
PATTERN MEASUREMENT FREQ. 2106MHZ
FREQ. RANGE: S-BAND
ENGRS: J. L. LINDSEY
SYSTEM: MSC ANTENNA RANGE PROJECT: APOLLO
SD-ESB-ANTENNA SYSTEMS SECTION