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A 1660 MHZ ANTENNA FOR A TWENTY-FOUR INCH EJECTABLE SPHERE

Project Director H. W. Haas

Project Engineer D. G. Henry
B. T. Buller

Contract No. AF 19(628)-5923

Project 7659, 7043, 6682

Task No. 765901, 668204

Scientific Report No. 1

February 1967

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CONTRACT MONITOR: Raymond E. Wilton

Prepared for

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
OFFICE OF AEROSPACE RESEARCH
UNITED STATES AIR FORCE
BEDFORD, MASSACHUSETTS

NEW MEXICO STATE UNIVERSITY
PHYSICAL SCIENCE LABORATORY
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PHYSICAL SCIENCE LABORATORY
NEW MEXICO STATE UNIVERSITY
Las Cruces, New Mexico

A 1680 MHZ ANTENNA FOR A TWENTY-FOUR INCH EJECTABLE SPHERE

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ABSTRACT

The PSL Model 24.006 quadraloop antenna was developed as a 1680 MHz telemetry antenna. The antenna is mounted on an ejectable twenty-four inch sphere, which is ejected from an Arcas type rocket. The antenna is designed to fit inside a nylon housing attached to the metal strut of the sphere. The Model 24.006 antenna was tested for radiation pattern, VSWR and mechanical integrity.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

1.0 INTRODUCTION

The Aerospace Instrumentation Laboratory of Air Force Cambr ge Research Laboratories requested the Physical Science Laboratory to develope a 1680 MHz telemetry antenna for an ejectable twenty-four inch sphere. The sphere is ejected from an Arcas type rocket. The antenna is mounted within a nylon housing attached to one end of the metal supporting strut of the sphere. The Model 24.006 quadraloop antenna was designed, fabricated and tested to fulfill this request.

2.0 ANTENNA DESCRIPTION

A Model 24.006 quadraloop antenna is shown in Fig. 1. The two radiating elements are fed 180 degrees out of phase with equal amplitude. The feed harness consisting of a phasing harness and feed cable is not shown in the figure. Figure 2 shows an assembled view of the nylon housing, antenna and metal strut. The metal strut shown in the figure is a prorotype used to determine the antenna's electrical characteristics.

The Model 24.006 antenna consists of two radiating elements fed 180 degrees out of phase. A flat metal plate between the two elements acts as an electrical ground plane and provides mechanical support for the elements through nylon standoffs. Support is provided for the radiating elements, feed connectors and ground plane by a circular, metal base plate.

The antenna is inserted into the housing so that the ground plane is butted against the extreme end (away from the strut) of the housing. Since the antenna is inserted against the extreme end of the housing, a space between the metal strut and base plate results and effectively introduces an unwanted, annular radiator. This unwanted radiator couples with the antenna degrading the radiation pattern and VSWR. Coupling effects of the unwanted radiator are eliminated by grounding the antenna to the strut by means of a metal collar on the outside of the housing. Butting against the strut, the metal collar extends over the edge of the base plate. The collar and antenna are grounded to each other by four screws. Both the collar and antenna are secured to the nylon housing by the four screws.

3.0 ELECTRICAL TESTS CONDUCTED

Electrical tests were conducted on the Model 24.006 antenna to determine its VSWR and radiation pattern characteristics. Since the transmitted rf power is expected to be low, less than one-half watt, the antenna was not tested for rf breakdown.

3.1 Antenna VSWR

A plot of VSWR versus frequency for the Model 24.006 antenna is shown in Fig. 3. The plot indicates a minimum VSWR of 1.25:1 at the tuned frequency of 1685 MHz. Bandwidth is ± 25 MHz from the tuned frequency for VSWR limits of 1.5:1.

The antenna was designed for a center frequency of 1680 MHz.

3.2 Radiation Pattern Measurements

Figure 4 depicts the affixed coordinate system used for the radiation pattern measurements of the Model 24.006 antenna. The radiation pattern measurements were recorded for linear E_θ and E_ϕ polarizations. The recorded patterns show a gain of 0 db with respect to isotropic. Gain was determined from a Scientific-Atlantic standard gain horn (Model SGH-1.1) which has a gain of 17 db above isotropic at 1680 MHz.

The radiation pattern contours are suitably smooth. As the patterns indicate, the coverage is good for any orientation of the strut mounted antenna. Figures 5 through 26 are the recorded radiation patterns of the Model 24.006 quadraloop antenna mounted within a nylon housing as indicated in Fig. 2. Figures 27 and 28 are the power contour plots of E_θ and E_ϕ, respectively.

4.0 MECHANICAL TEST CONDUCTED

The Model 24.006 quadraloop antenna was vibrated mechanically from 20 to 2000 cps at a magnitude of 15 g's. Three orthogonal planes of the antenna were tested with a sweep time of three (3) minutes for each plane. There were no electrical or mechanical failures.

Total weight of the antennas including the phase harness and feed cable is 70.5 gms.

5.0 CONCLUSIONS

The PSL Model 24.006 quadraloop antenna met all electrical and mechanical requirements. The antenna is mounted inside a nylon housing attached to the end of a metal strut of the ejectable sphere. The radiation patterns are extremely satisfactory. The VSWR and bandwidth are quite adequate and the mechanical structure of the antenna is sound. The Model 24.006 antenna should perform the desired data transmission most satisfactorily.

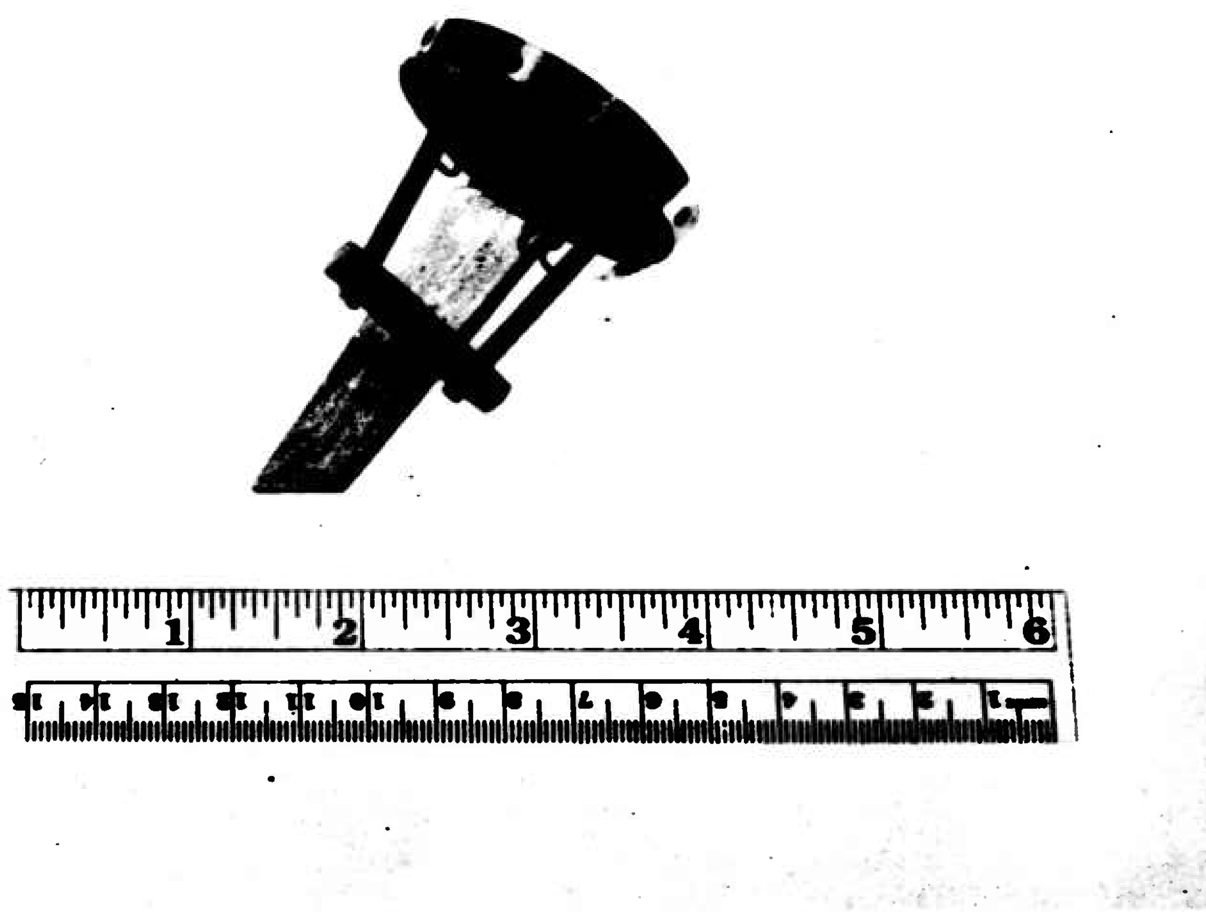


FIG. 1 - PSL MODEL 24.006 QUADRALOOP ANTENNA

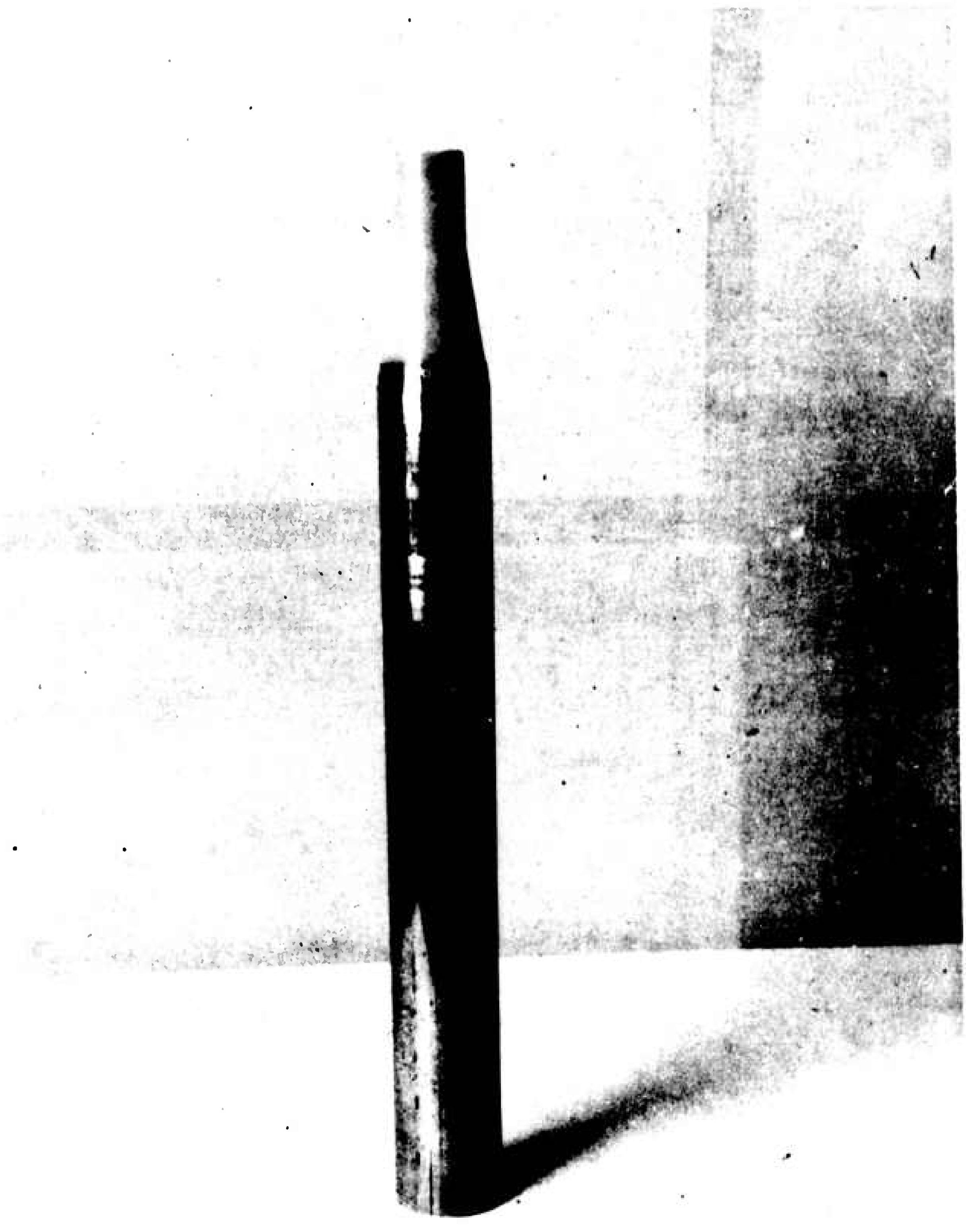


FIG. 2 - ASSEMBLE VIEW OF PSL MODEL 24.006 QUADRALOOP ANTENNA SHOWING HOUSING, COLLAR AND PROTOTYPE STRUT

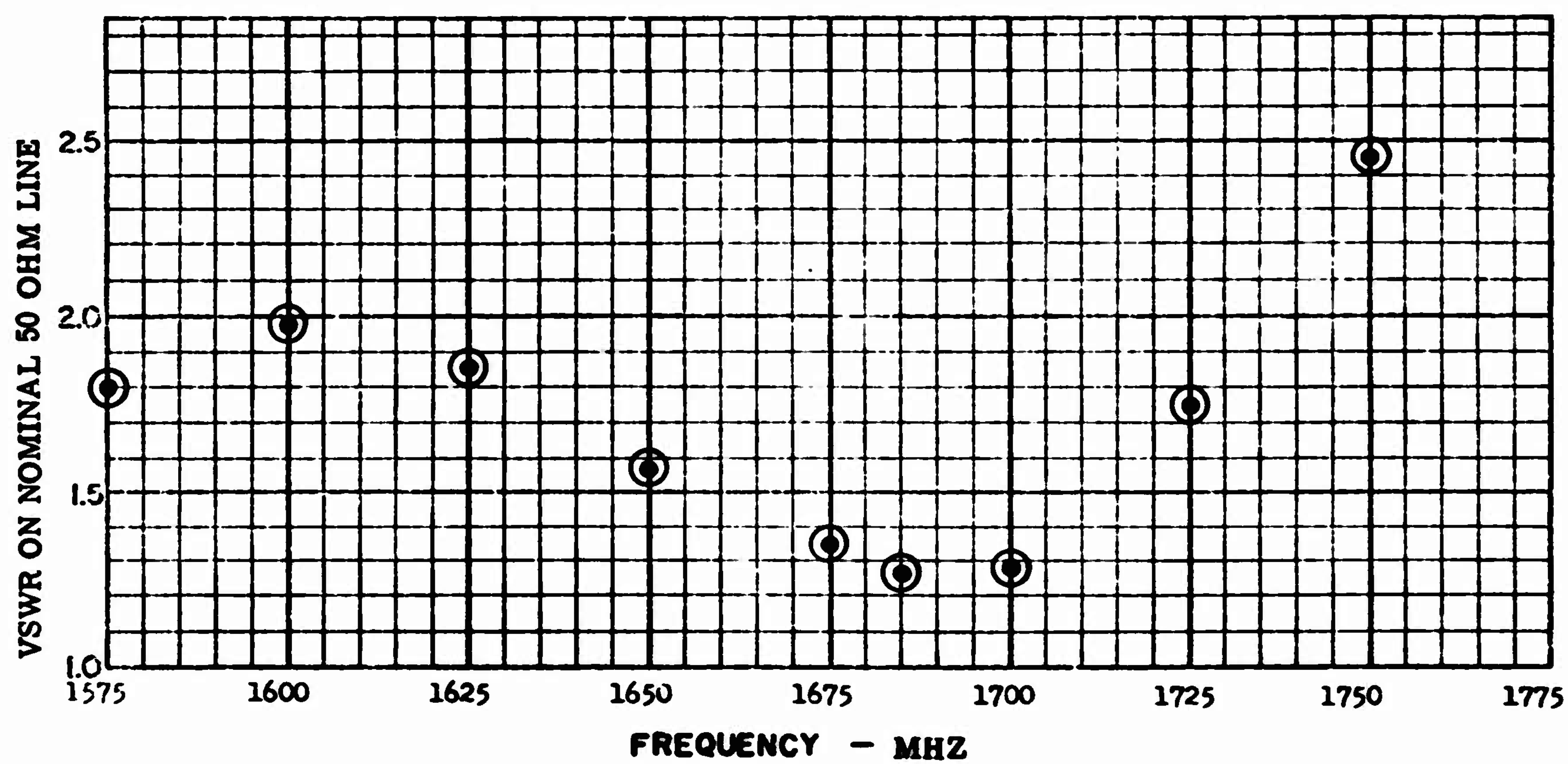


FIG. 3 - VSWR VERSUS FREQUENCY FOR A MODEL 24.006 QUADRALOOP ANTENNA

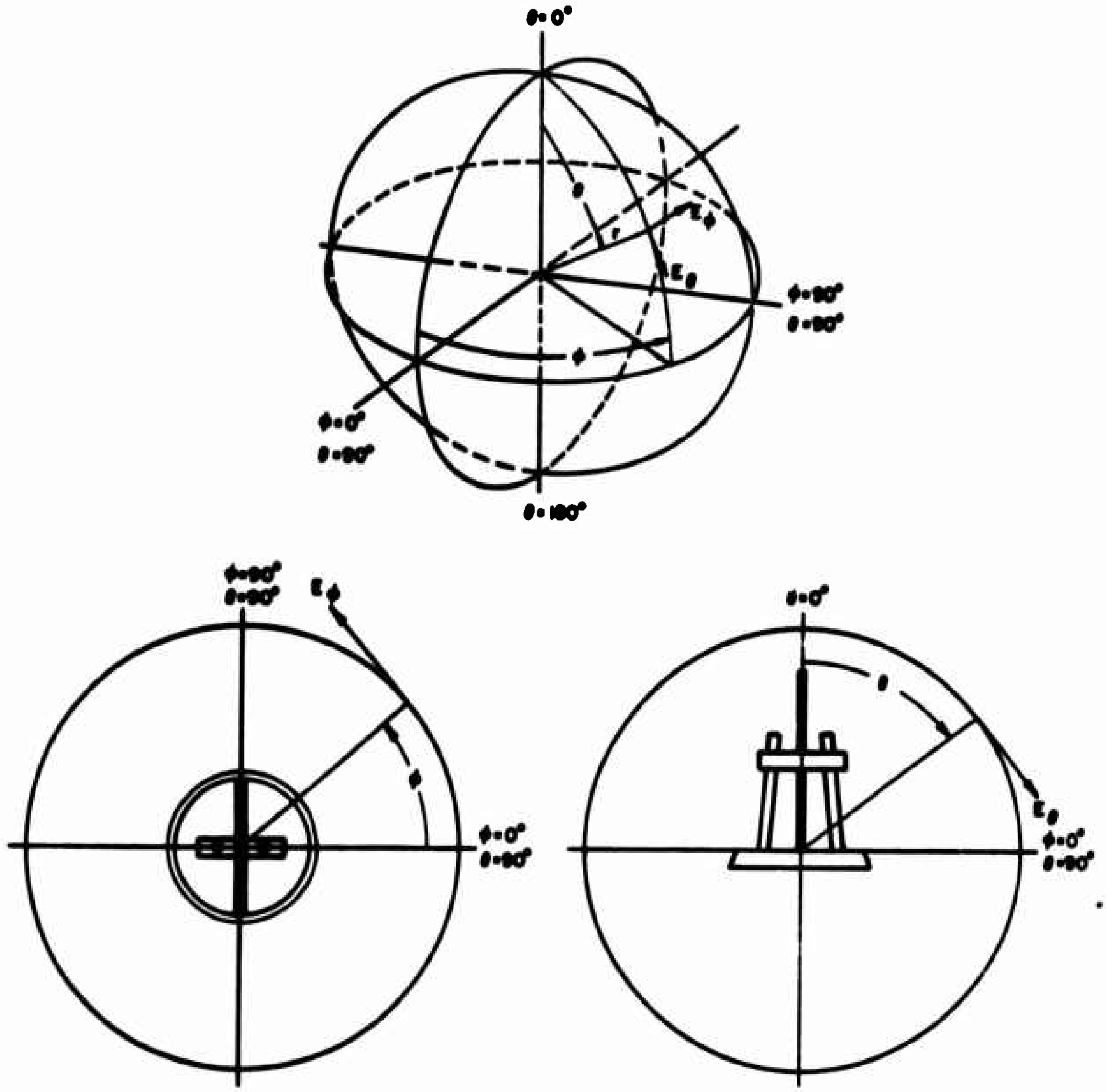


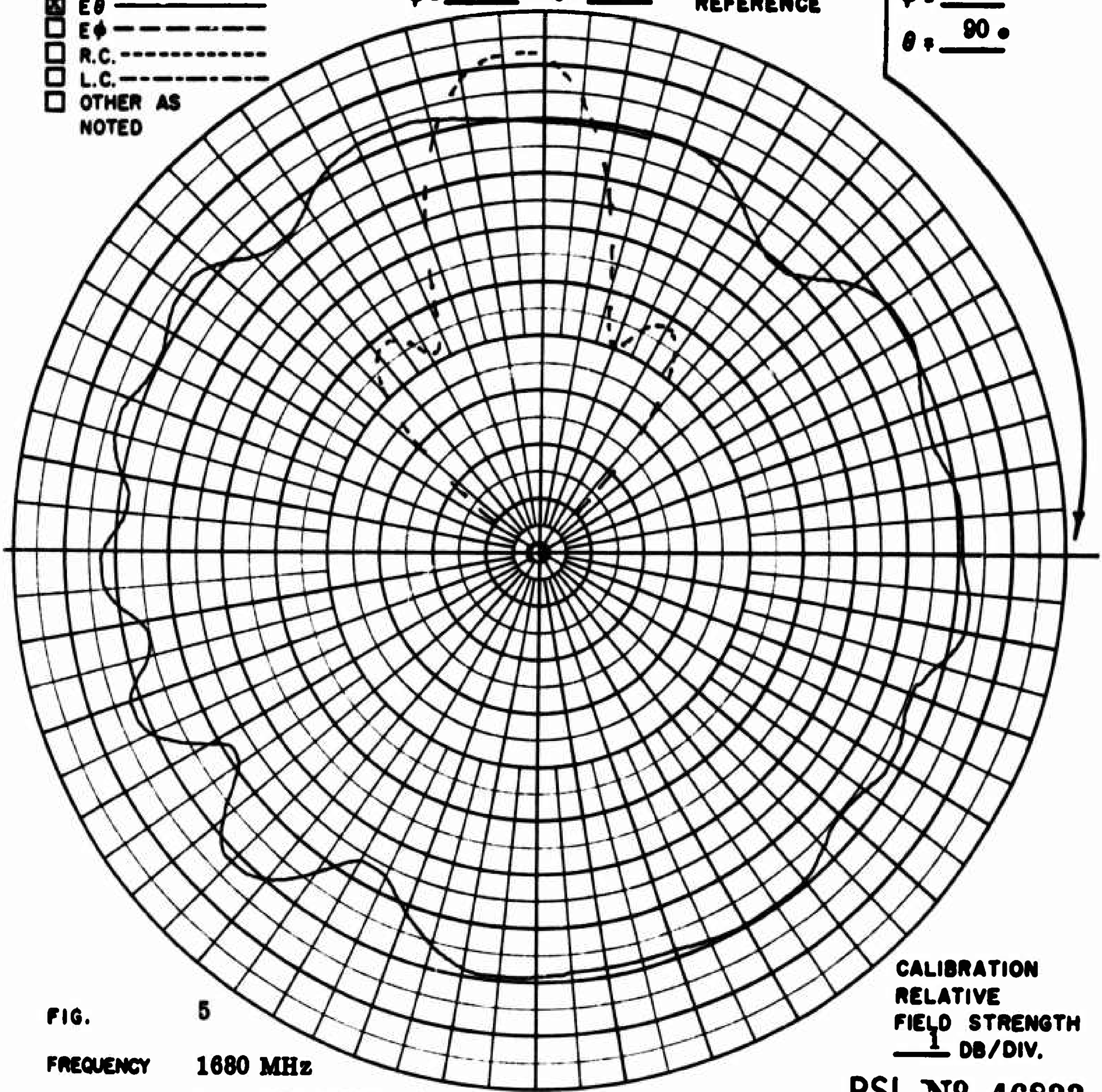
FIG. 4 - MODEL 24.006 ANTENNA COORDINATE SYSTEM

POLARIZATION

- [x] GAIN REF -- -- --
- [x] Eθ ————
- [ ] Eφ — — — —
- [ ] R.C. ------------
- [ ] L.C. —-—-—-—
- [ ] OTHER AS NOTED

φ = ____ ° θ = 0 ° COORDINATE REFERENCE

φ = 0 °
θ = 90 °



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL № 46833

FIG. 5

FREQUENCY 1680 MHz

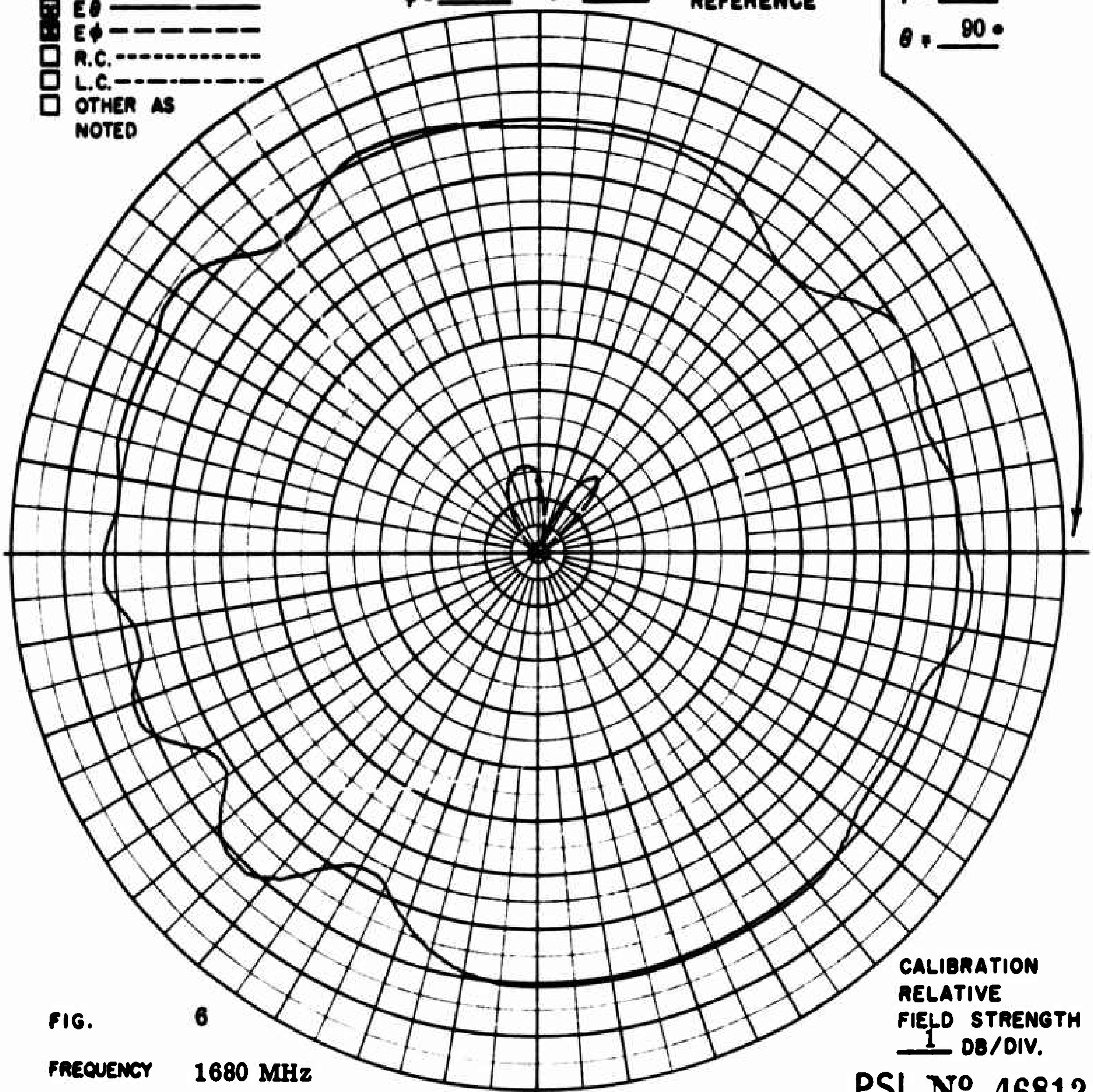
ANTENNA Model 24.006 Quadraloop

REMARKS Gain reference is + 17 db standard gain horn. The gain reference pattern is attenuated by 14 db.

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ———————
- ☒ Eφ — — — — — —
- ☐ R.C. ------------
- ☐ L.C. —·—·—·—·—
- ☐ OTHER AS NOTED

φ = ____ ° θ = 0 ° COORDINATE REFERENCE φ = 0 ° θ = 90 °



CALIBRATION RELATIVE FIELD STRENGTH 1 DB/DIV.

FIG. 6

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

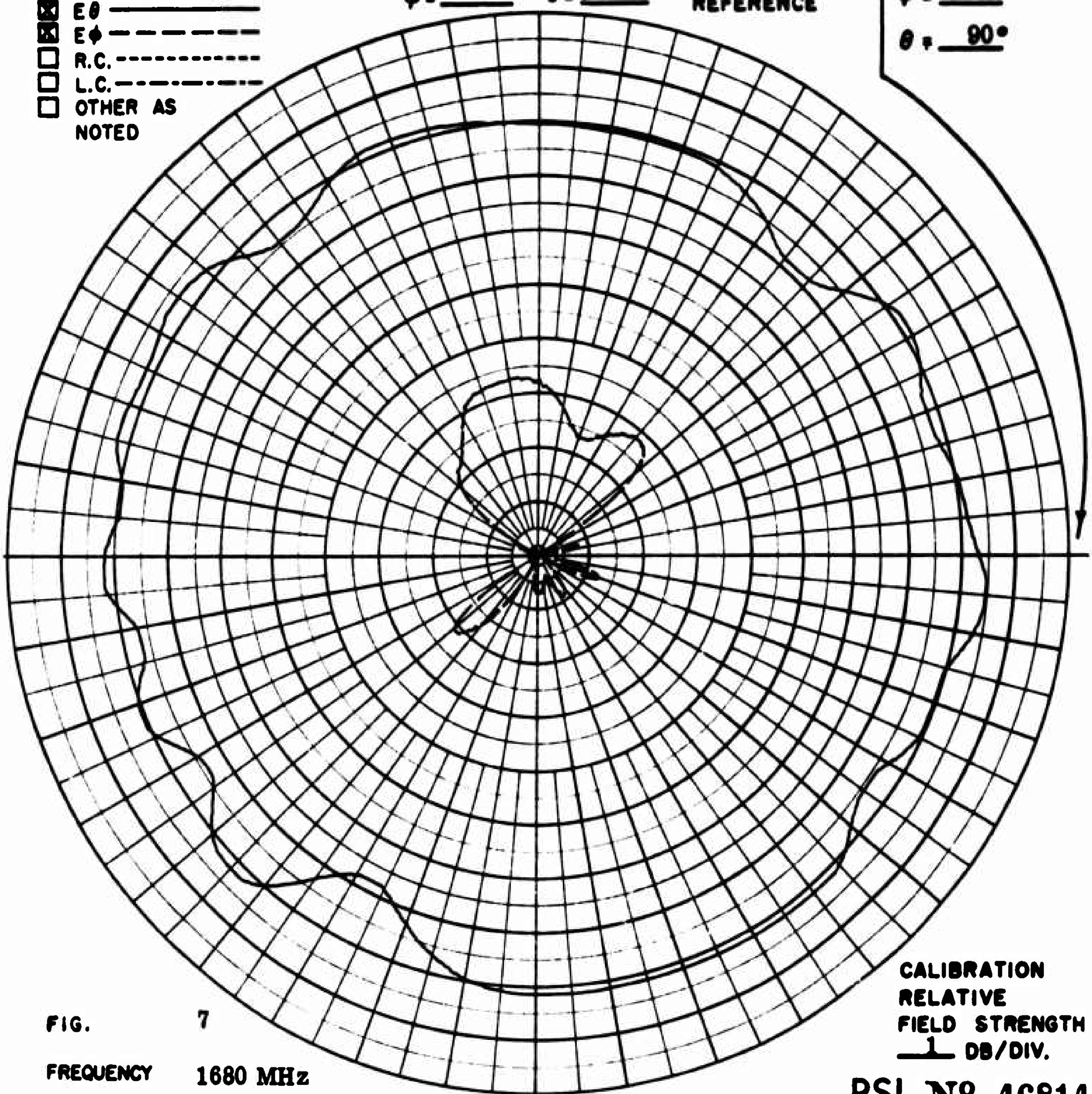
PSL Nº 46812

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eφ — — — — —
- ☐ R.C. - - - - - - - - -
- ☐ L.C. —·—·—·
- ☐ OTHER AS NOTED

φ = ____ ° θ = 0 ° COORDINATE REFERENCE

φ = 10°
θ = 90°



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL № 46814

FIG. 7

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

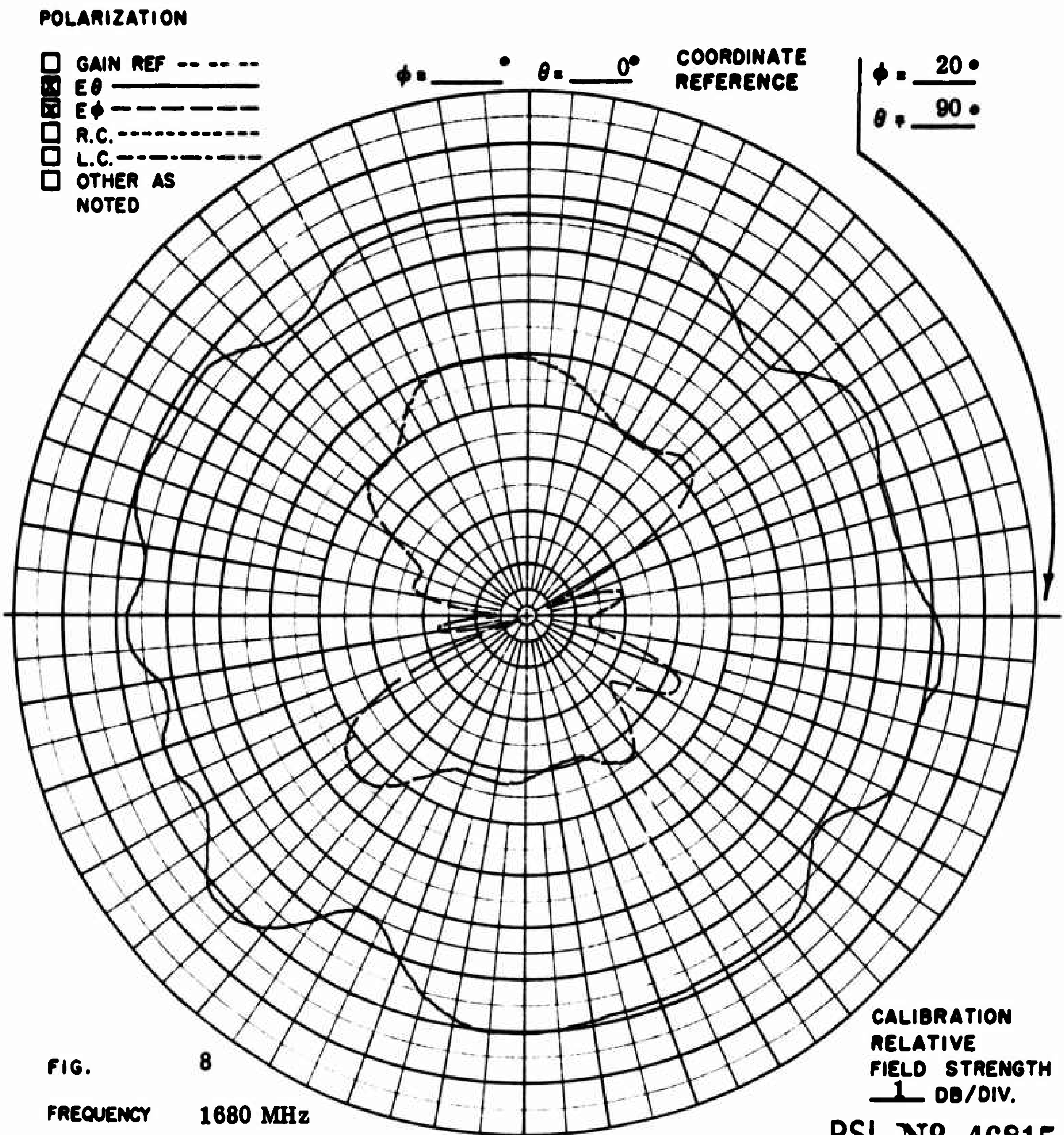


FIG. 8

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

PSL № 46815

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eϕ — — — —
- ☐ R.C. ----------
- ☐ L.C. —-—-—-—
- ☐ OTHER AS NOTED

ϕ = ___° θ = 0° COORDINATE REFERENCE

ϕ = 30°
θ = 90°

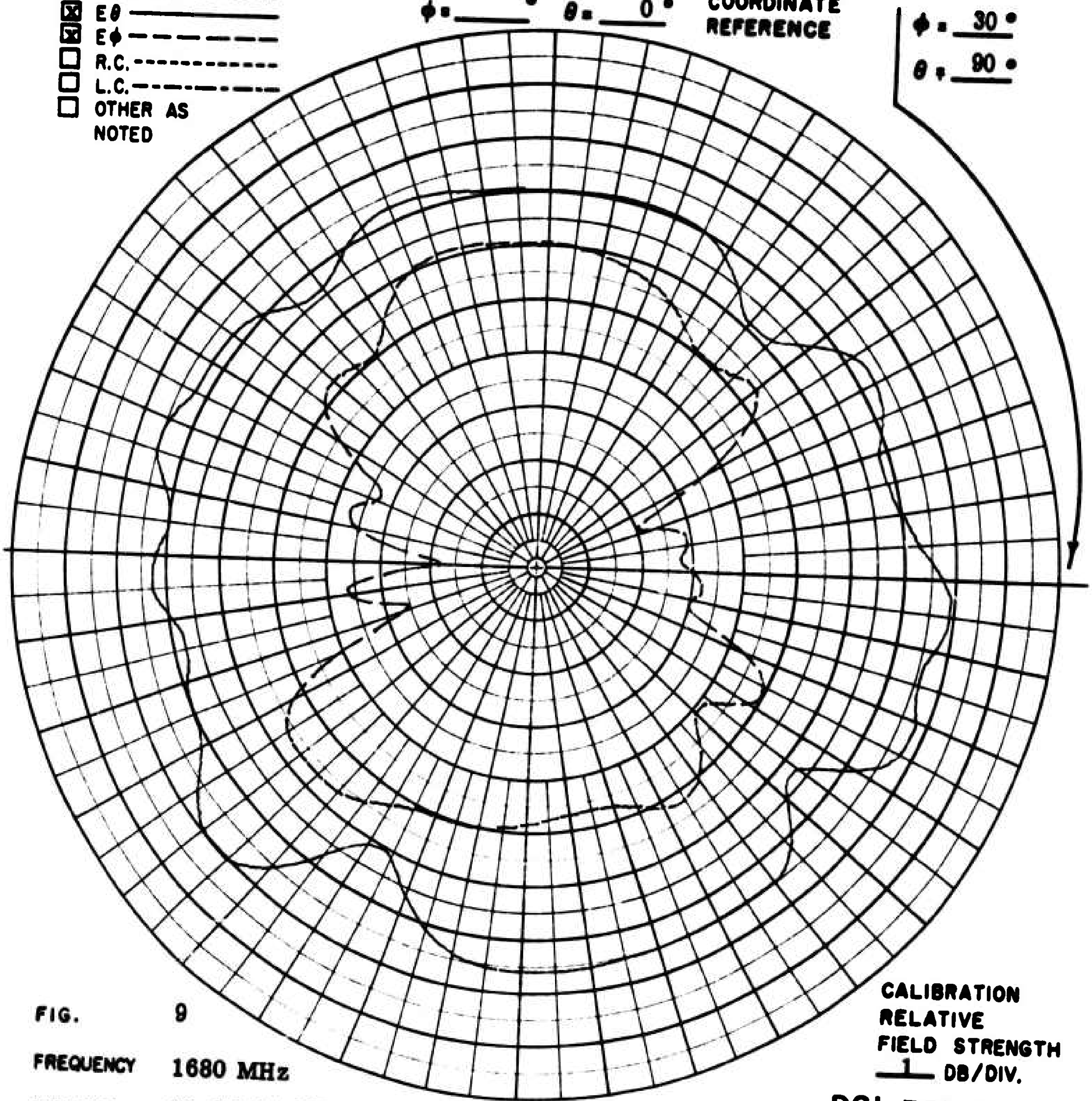


FIG. 9

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

CALIBRATION RELATIVE FIELD STRENGTH 1 DB/DIV.

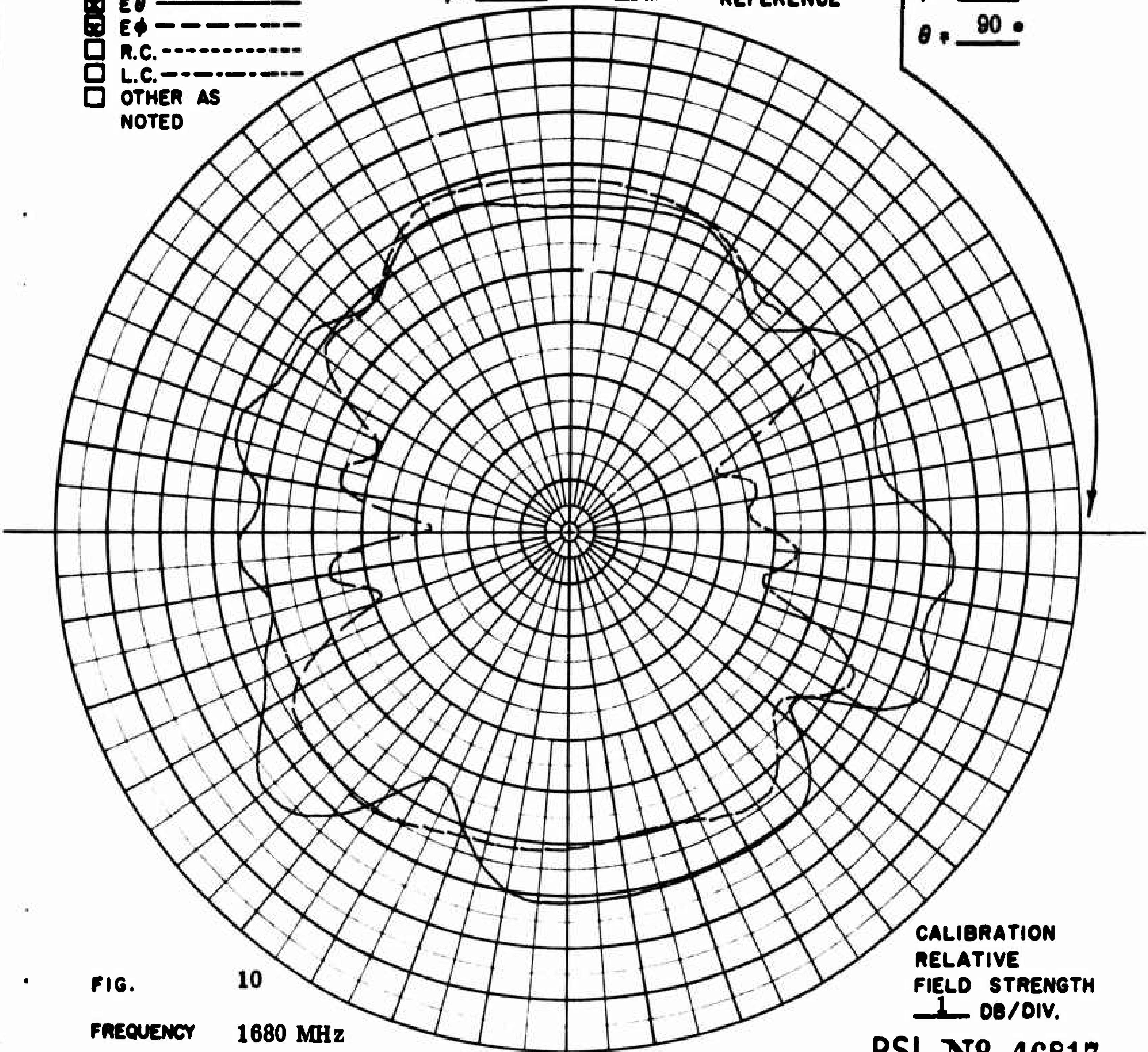
PSL № 46816

POLARIZATION

- ☐ GAIN REF - - - - -
- ☒ Eθ ————————
- ☒ Eϕ — — — — — —
- ☐ R.C. ------------
- ☐ L.C. —-—-—-—
- ☐ OTHER AS NOTED

ϕ = ____ ° θ = 0 ° COORDINATE REFERENCE

ϕ = 40 °
θ = 90 °



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL Nº 46817

FIG. 10

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eφ — — — — —
- ☐ R.C. ------------
- ☐ L.C. —-—-—-—-
- ☐ OTHER AS NOTED

φ = ____ ° θ = 0 ° COORDINATE REFERENCE

φ = 50 °
θ = 90 °

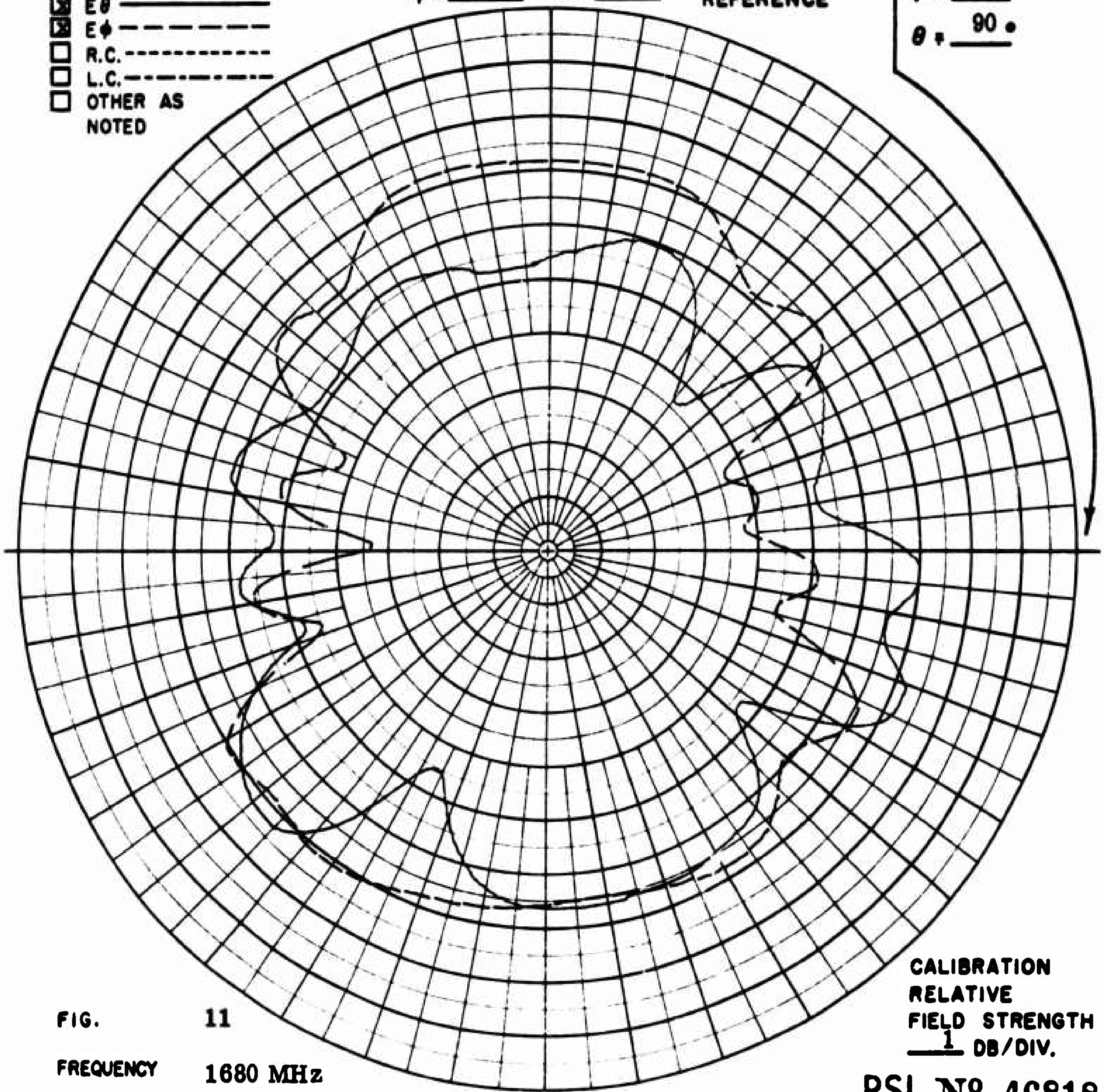


FIG. 11

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

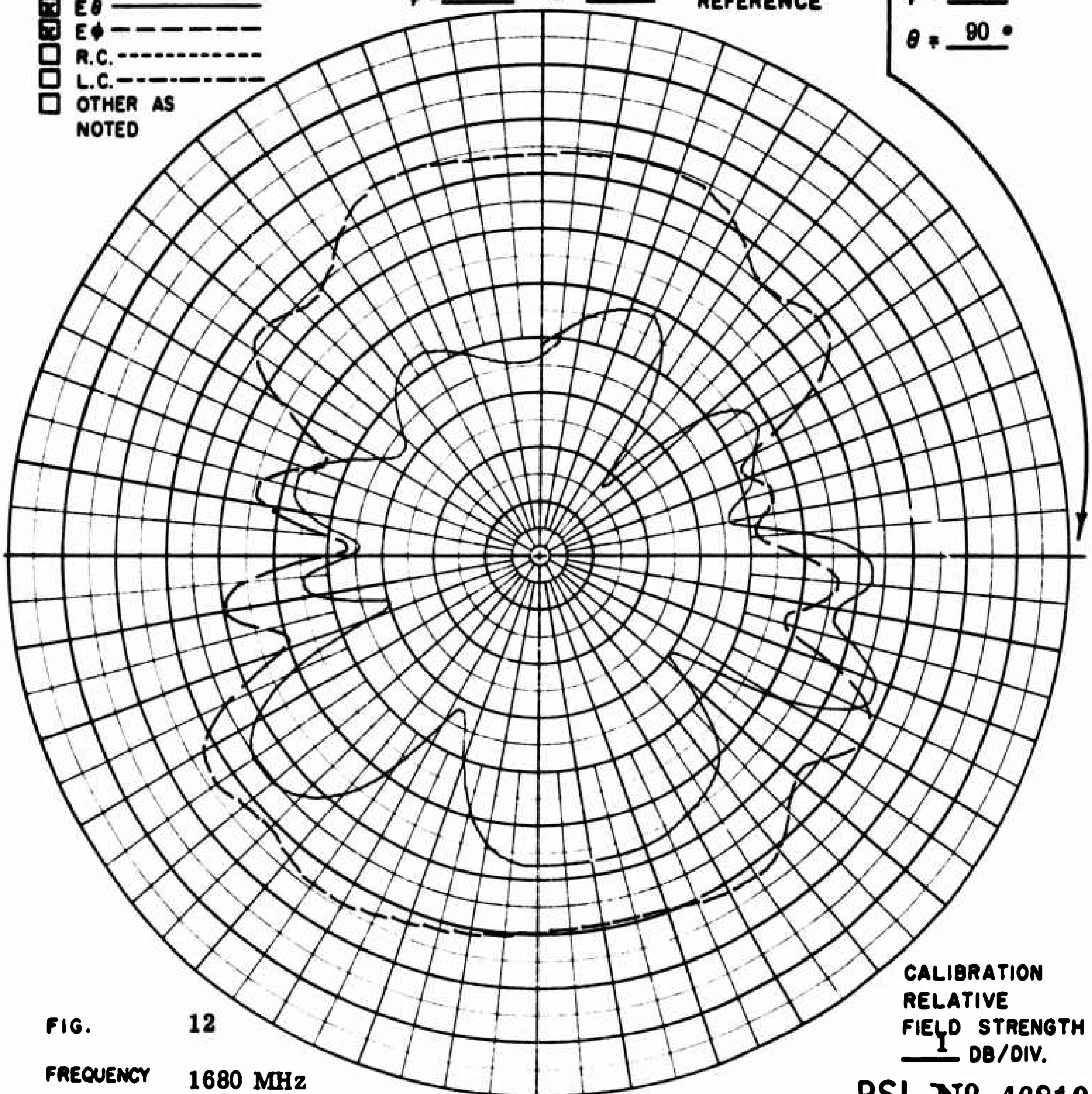
PSL Nº 46818

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eφ — — — —
- ☐ R.C. -----------
- ☐ L.C. —·—·—·—
- ☐ OTHER AS NOTED

φ = ____ ° θ = 0 ° COORDINATE REFERENCE

φ = 60 °
θ = 90 °



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL Nº 46819

FIG. 12

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

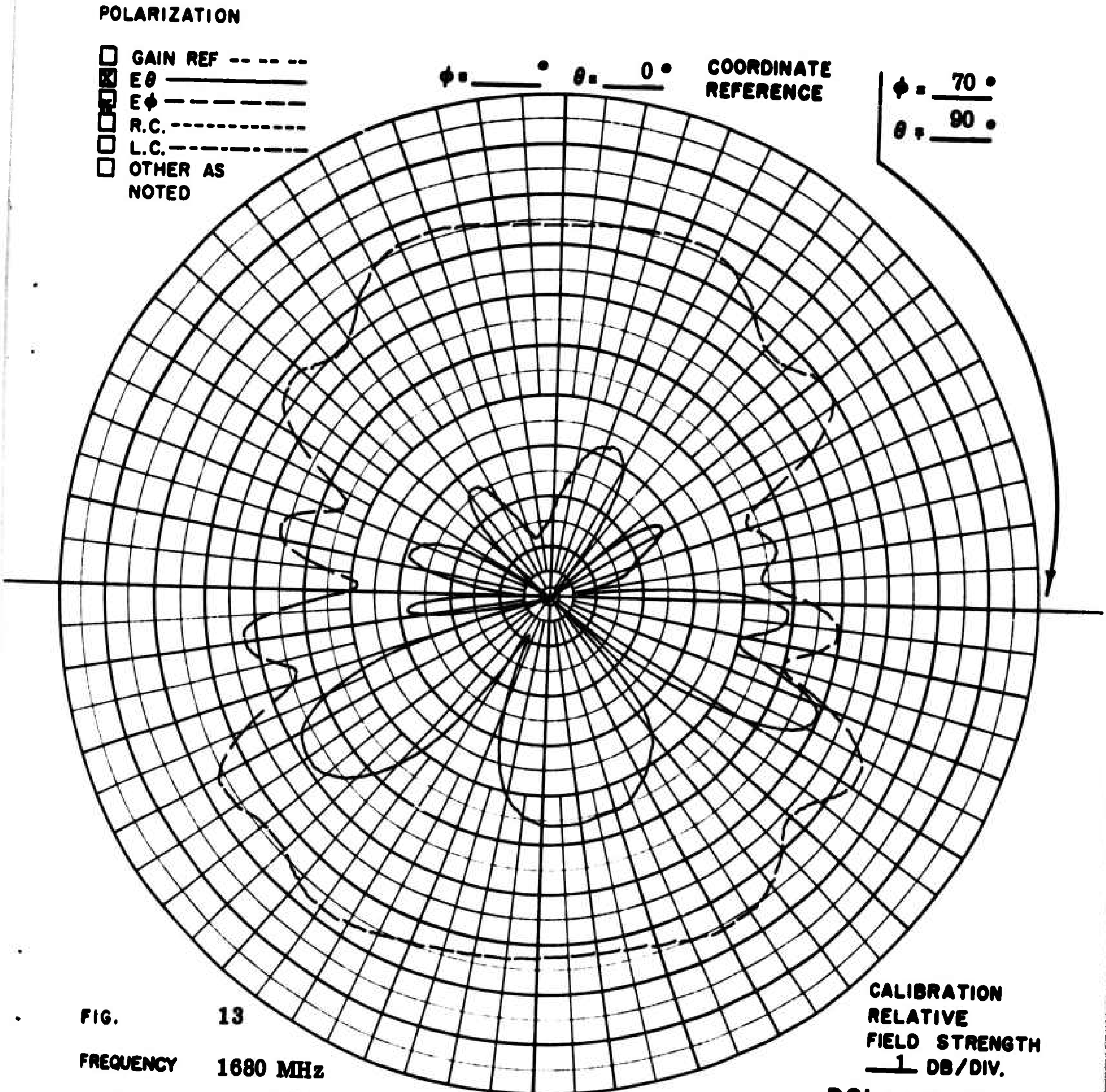


FIG. 13

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

PSL Nº 46820

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eϕ — — — —
- ☐ R.C. ------------
- ☐ L.C. —-—-—-
- ☐ OTHER AS NOTED

ϕ = ____ ° θ = 0 ° COORDINATE REFERENCE

ϕ = 80 °
θ = 90 °

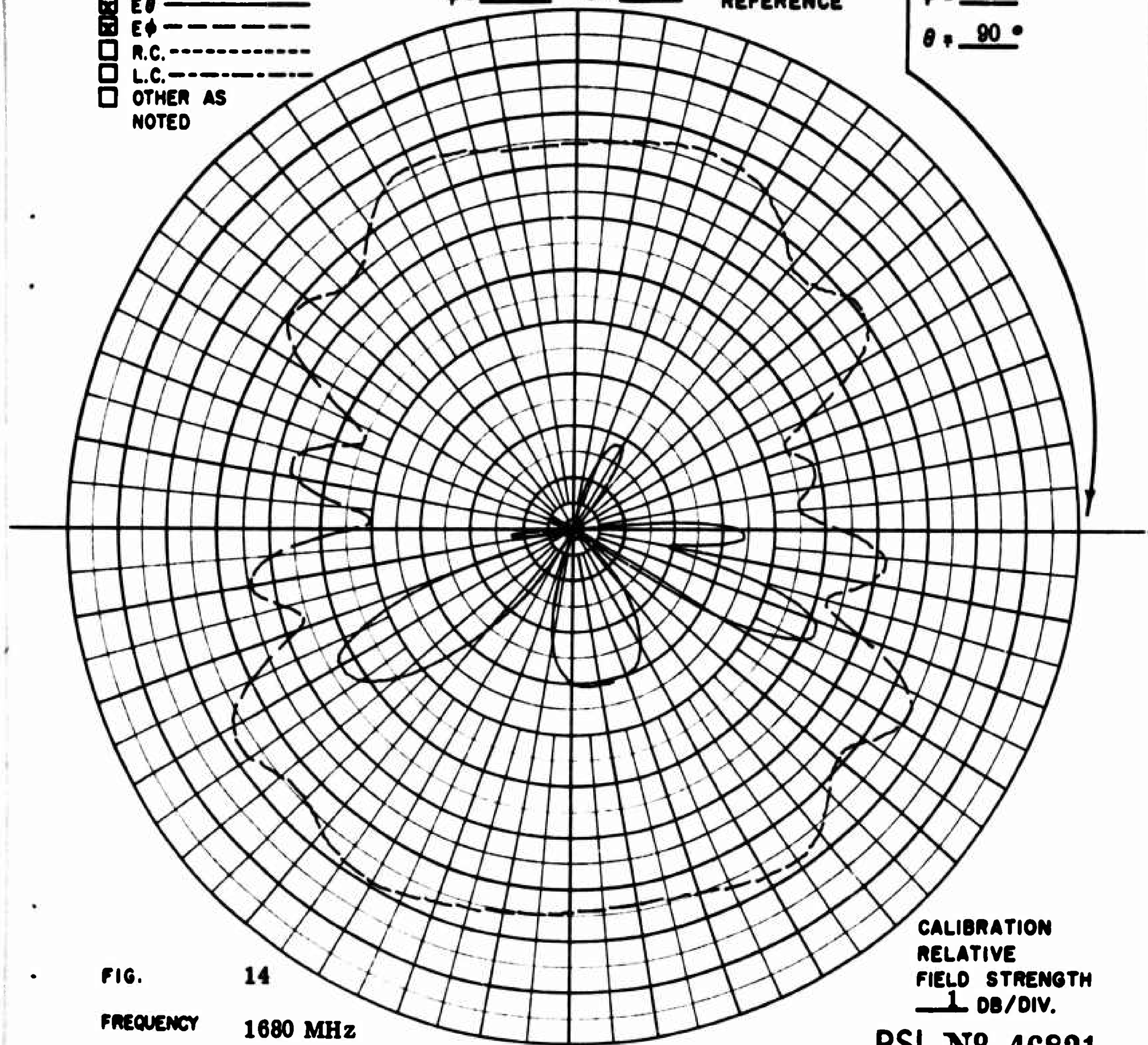


FIG. 14

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

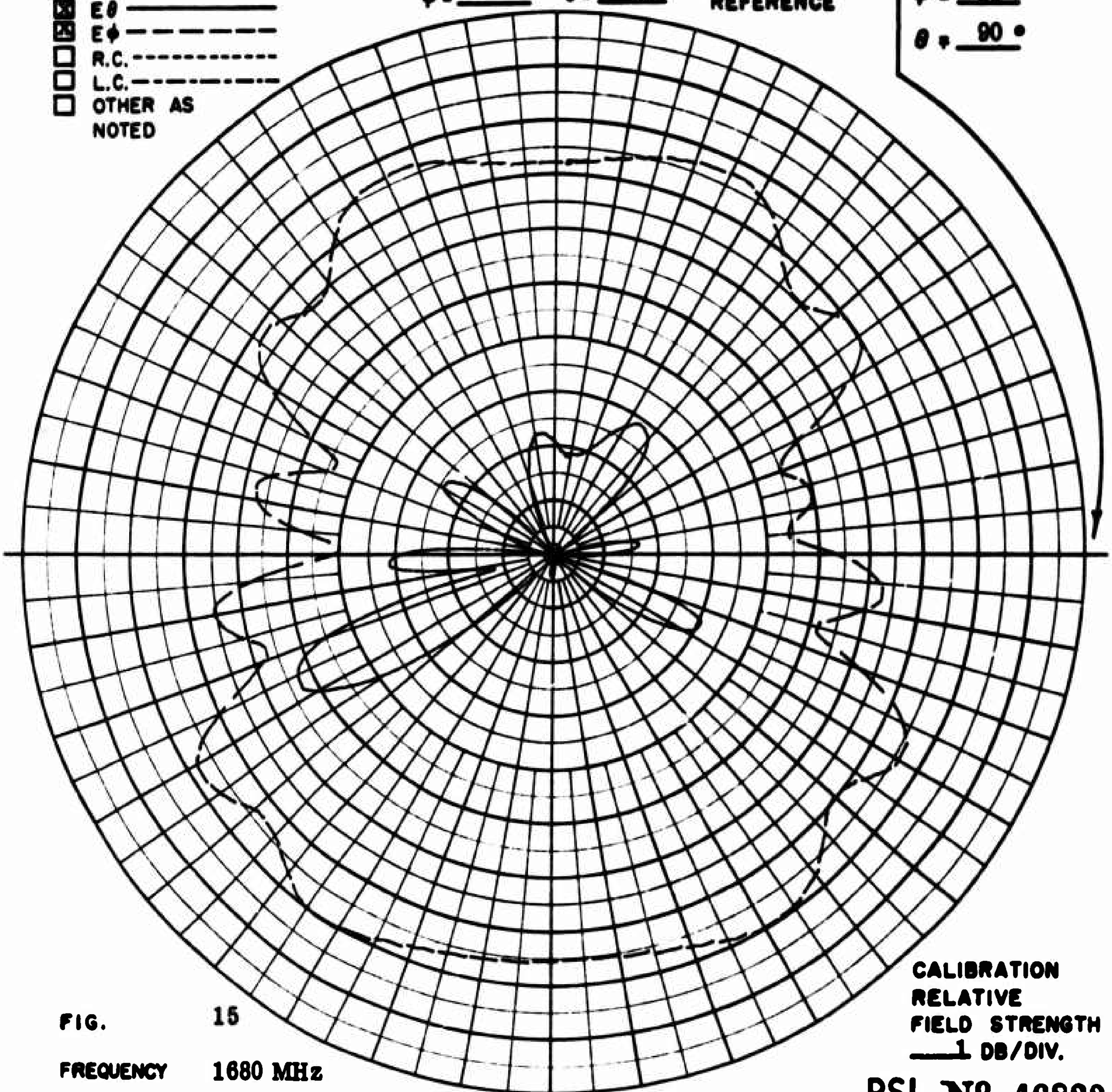
PSL № 46821

POLARIZATION

- ☐ GAIN REF
- ☒ Eθ
- ☒ Eφ
- ☐ R.C.
- ☐ L.C.
- ☐ OTHER AS NOTED

φ = ____° θ = 0° COORDINATE REFERENCE

φ = 90°
θ = 90°



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL Nº 46822

FIG. 15

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

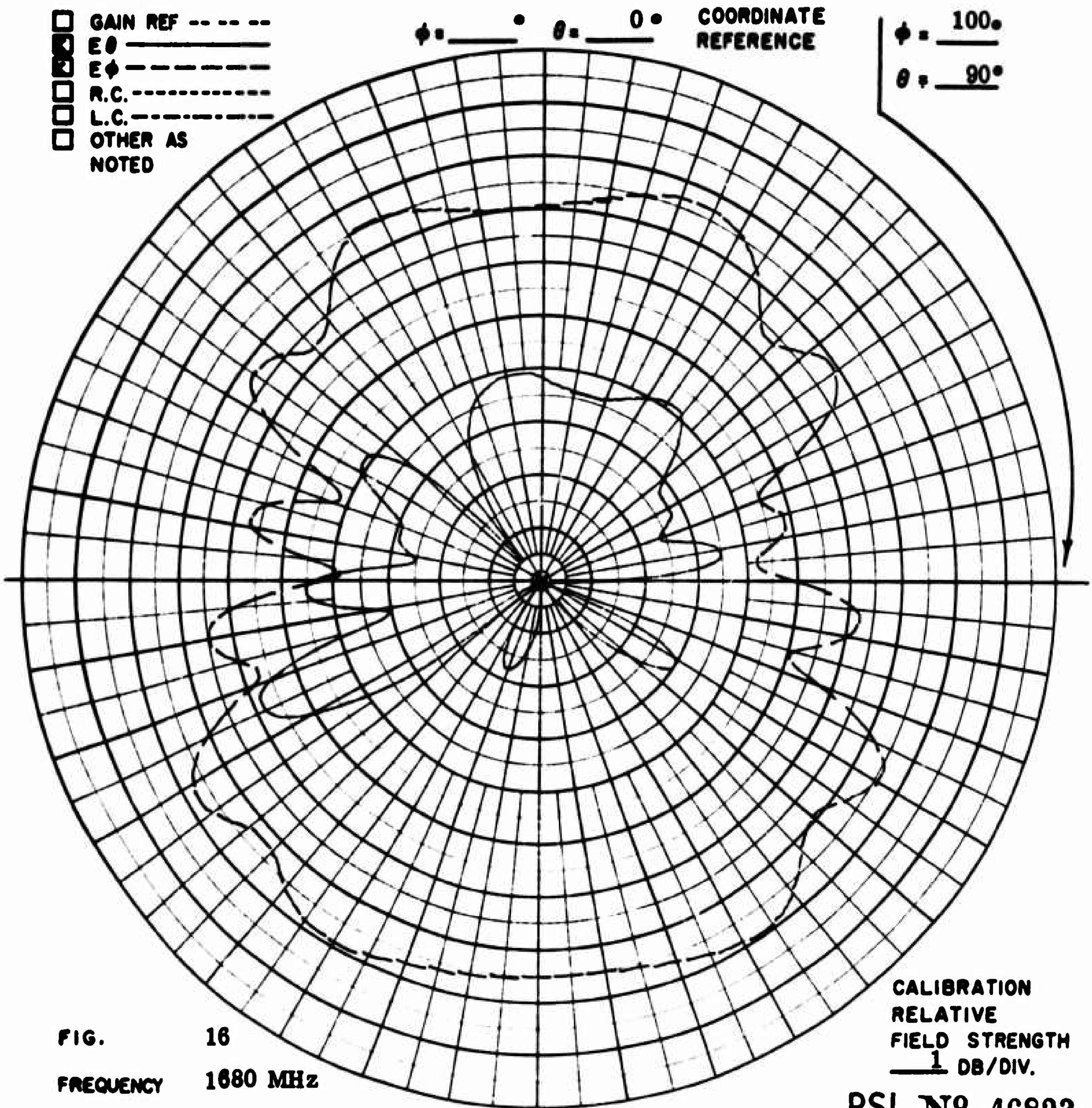


FIG. 16

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

PSL Nº 46823

POLARIZATION

- [ ] GAIN REF -- -- --
- [x] Eθ ————
- [x] Eϕ — — — —
- [ ] R.C. ------------
- [ ] L.C. —-—-—-—
- [ ] OTHER AS NOTED

ϕ = ____° θ = 0° COORDINATE REFERENCE

ϕ = 110°
θ = 90°

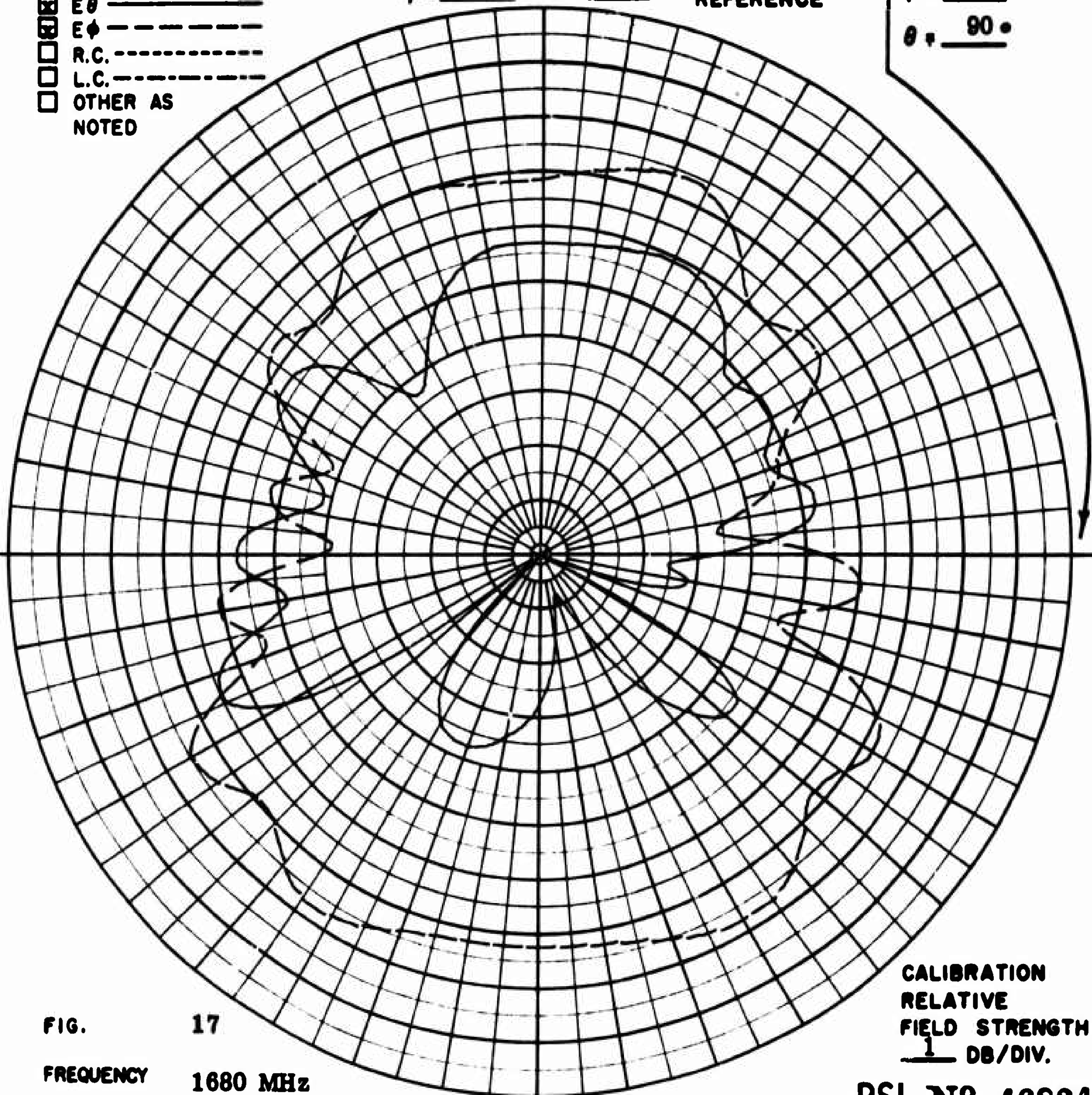


FIG. 17

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL Nº 46824

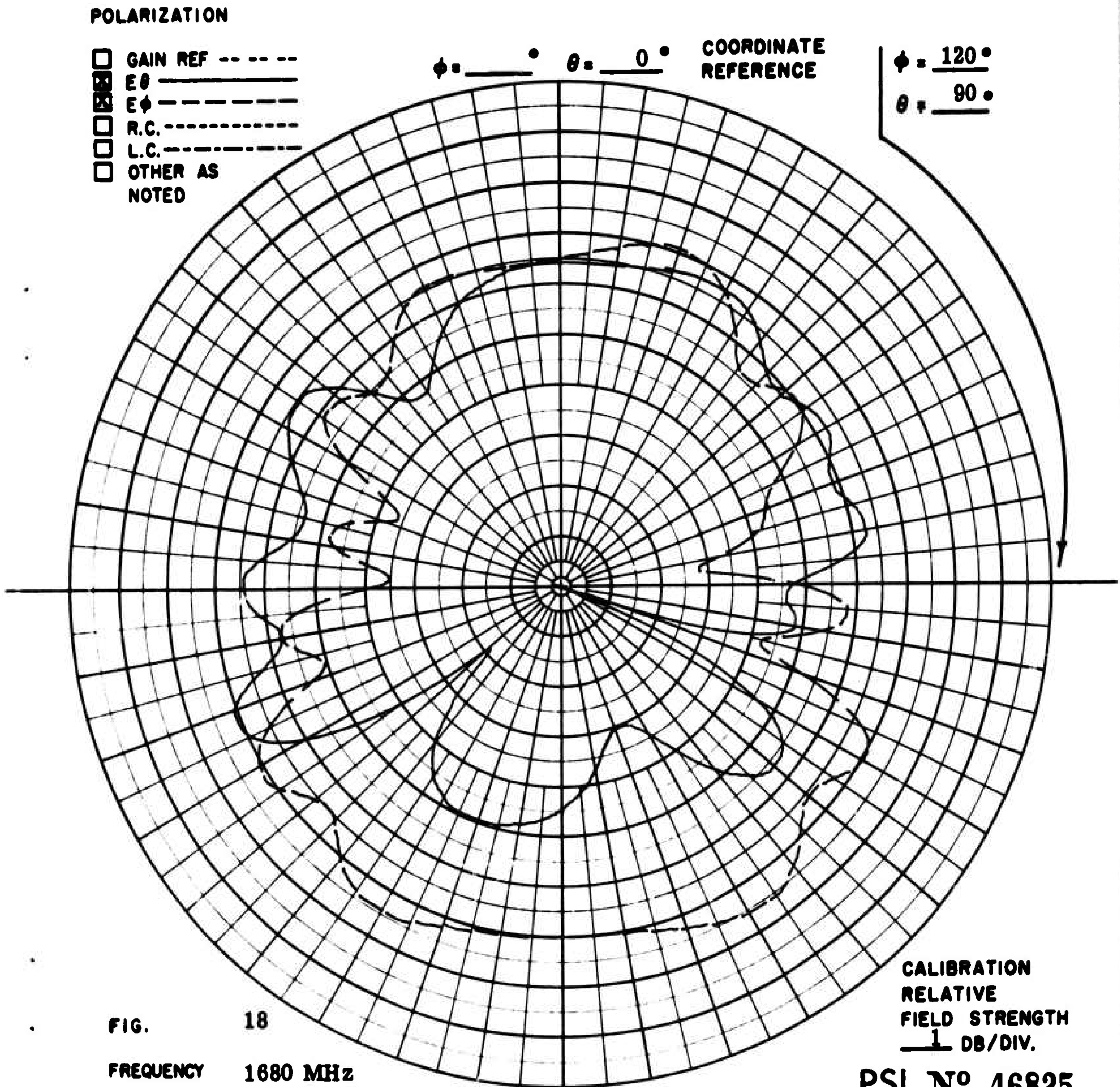


FIG. 18

FREQUENCY 1680 MHz

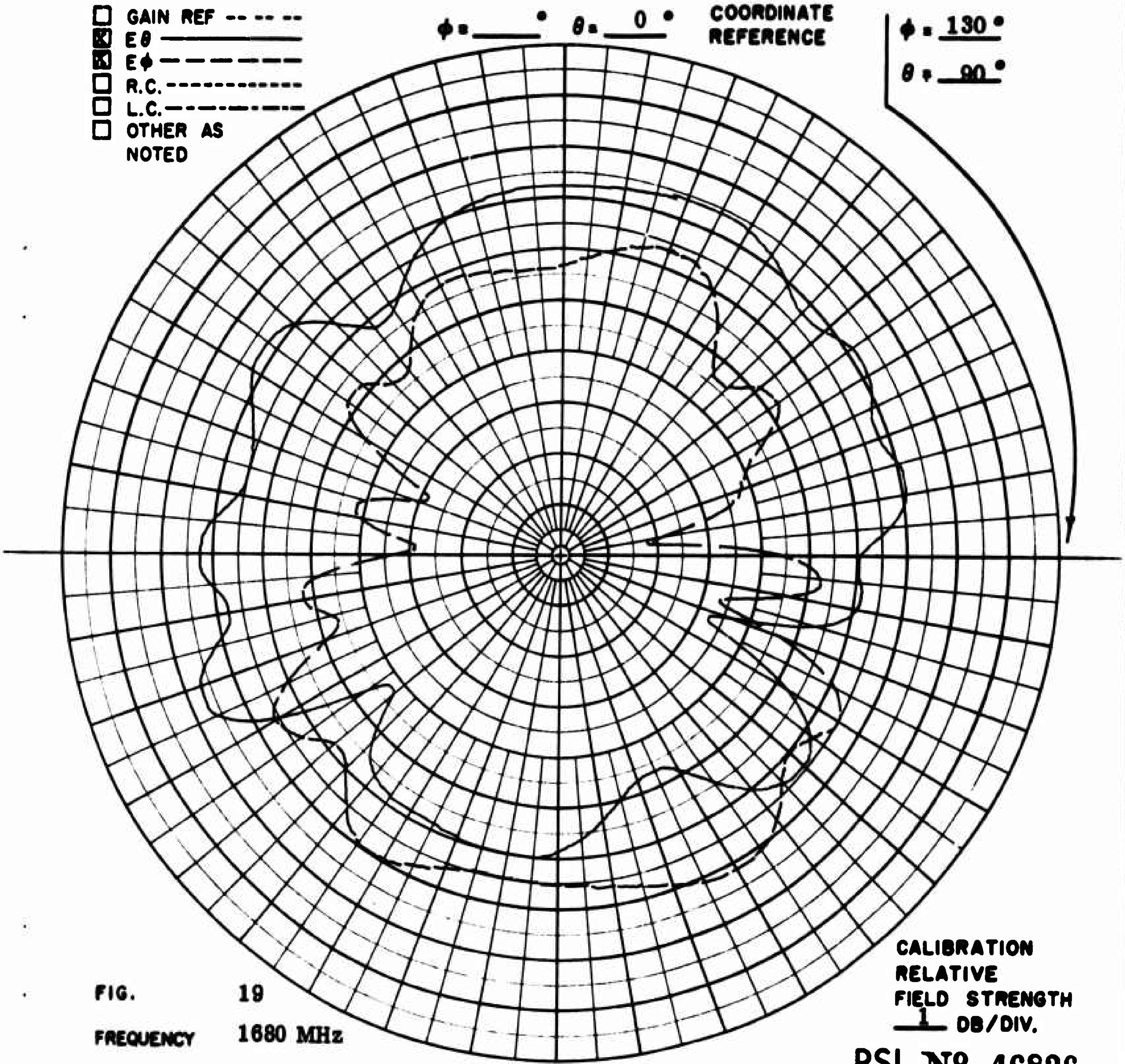
ANTENNA Model 24.006

REMARKS

PSL Nº 46825

POLARIZATION

- ☐ GAIN REF - - - - - -
- ☒ Eθ ————————
- ☒ Eϕ — — — — — —
- ☐ R.C. - - - - - - - - - - - -
- ☐ L.C. —-—-—-—-—
- ☐ OTHER AS NOTED



CALIBRATION RELATIVE FIELD STRENGTH 1 DB/DIV.

PSL Nº 46826

FIG. 19

FREQUENCY 1680 MHz

ANTENNA Model 24.006

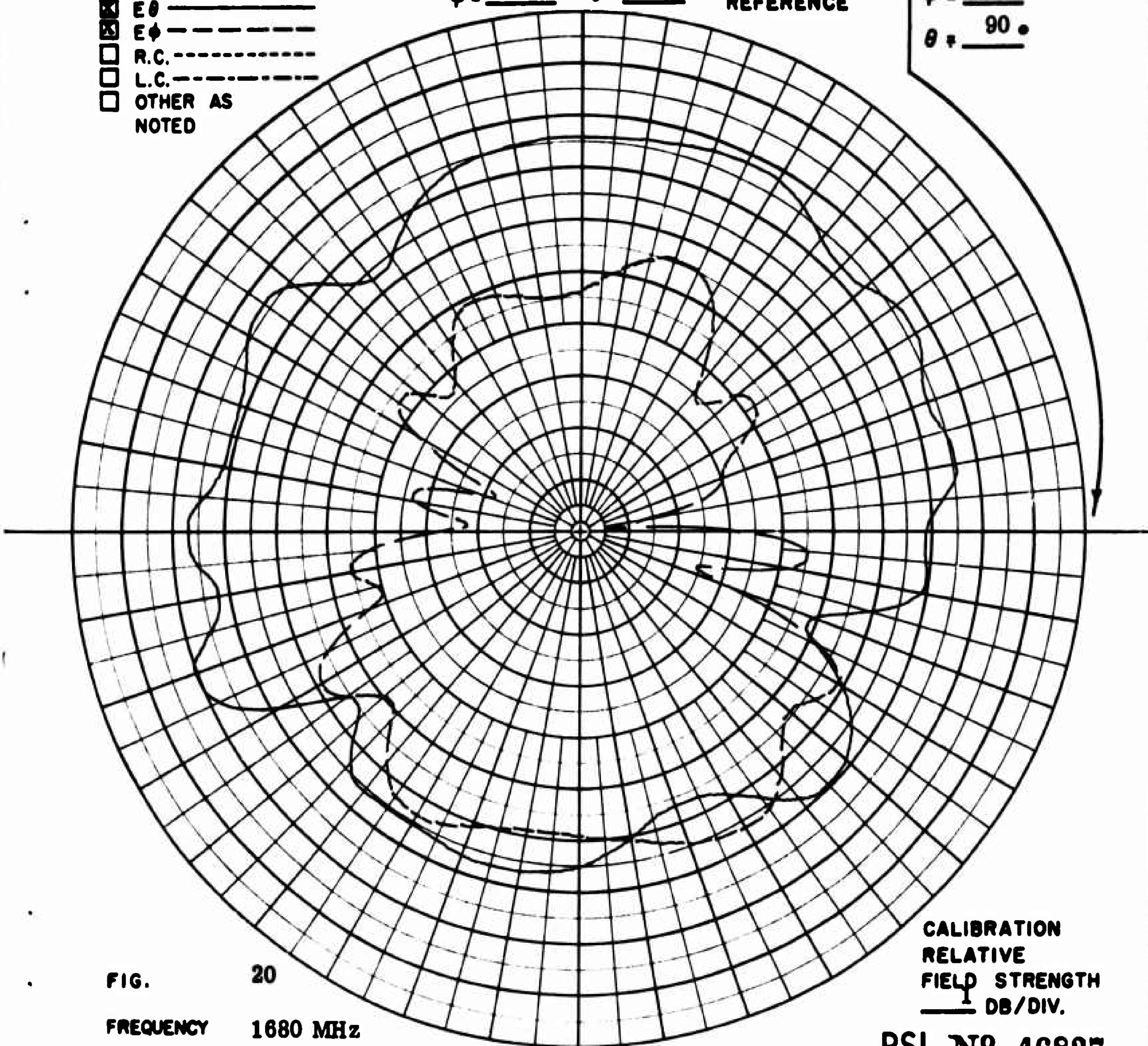
REMARKS

POLARIZATION

- ☐ GAIN REF -- -- --
- ☒ Eθ ————
- ☒ Eφ — — — —
- ☐ R.C. - - - - - -
- ☐ L.C. —·—·—
- ☐ OTHER AS NOTED

φ = ____° θ = 0° COORDINATE REFERENCE

φ = 140°
θ = 90°



CALIBRATION RELATIVE FIELD STRENGTH 1 DB/DIV.

PSL № 46827

FIG. 20

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

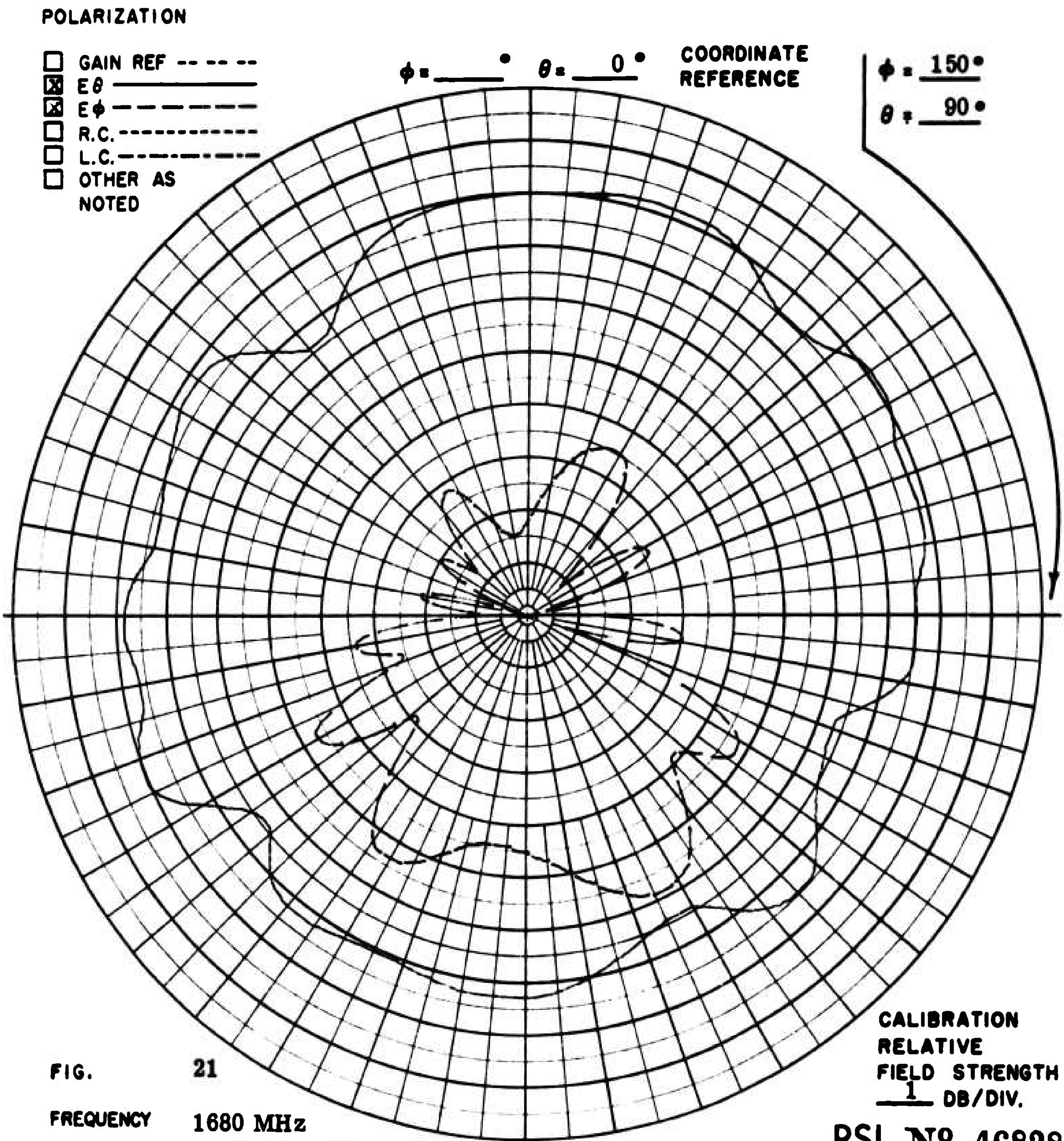


FIG. 21

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

PSL № 46828

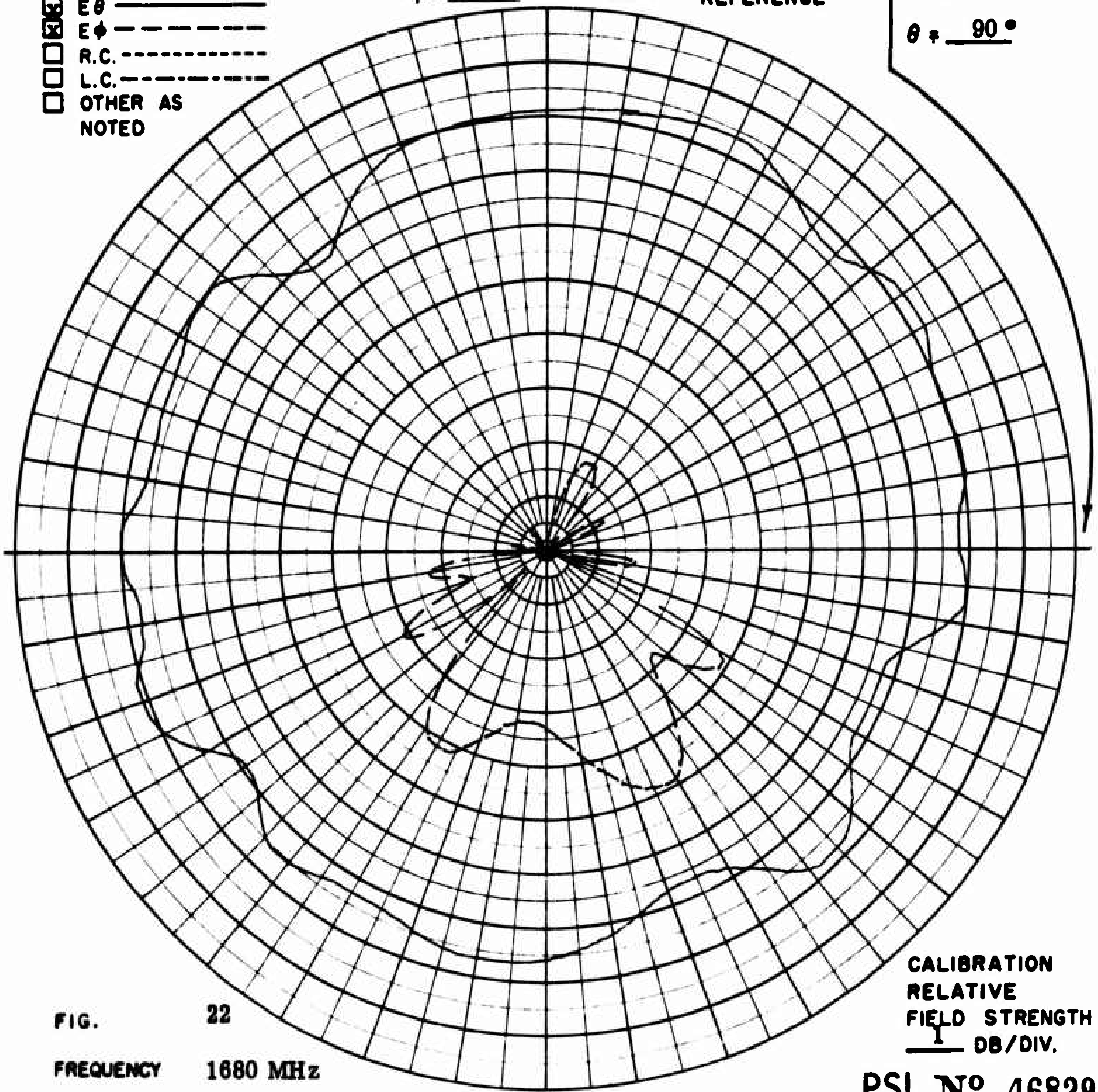
POLARIZATION

- ☐ GAIN REF - - - - -
- ☒ Eθ ————
- ☒ Eφ — — — —
- ☐ R.C. - - - - - - -
- ☐ L.C. —·—·—·—
- ☐ OTHER AS NOTED

φ = ____ ° θ = 0 °

COORDINATE REFERENCE

φ = 160 °
θ = 90 °



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL № 46829

FIG. 22

FREQUENCY 1680 MHz

ANTENNA Model 24.006

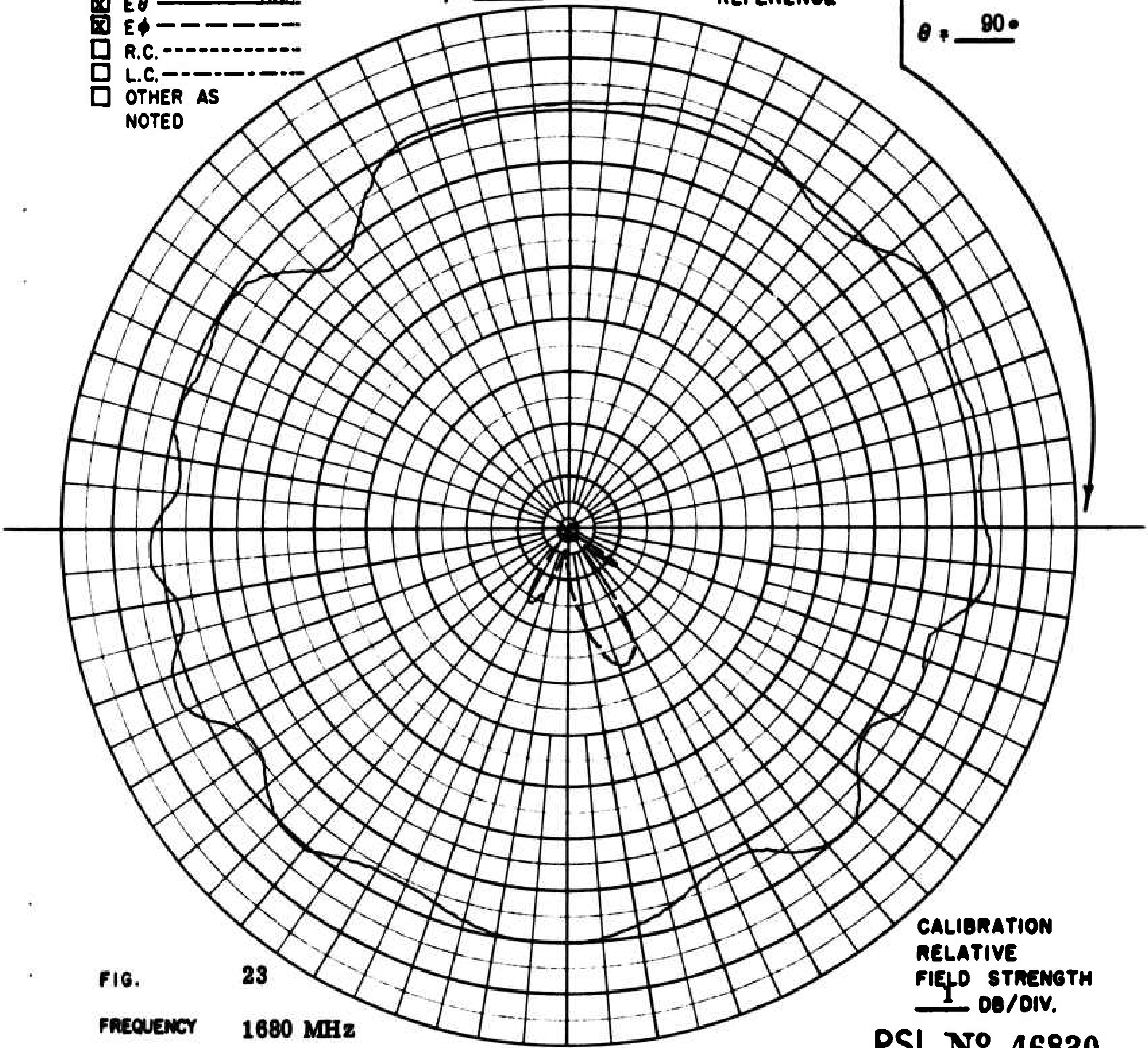
REMARKS

POLARIZATION

- ☐ GAIN REF
- ☒ Eθ
- ☒ Eφ
- ☐ R.C.
- ☐ L.C.
- ☐ OTHER AS NOTED

φ = ____° θ = 0° COORDINATE REFERENCE

φ = 170°
θ = 90°



CALIBRATION RELATIVE FIELD STRENGTH 1 DB/DIV.

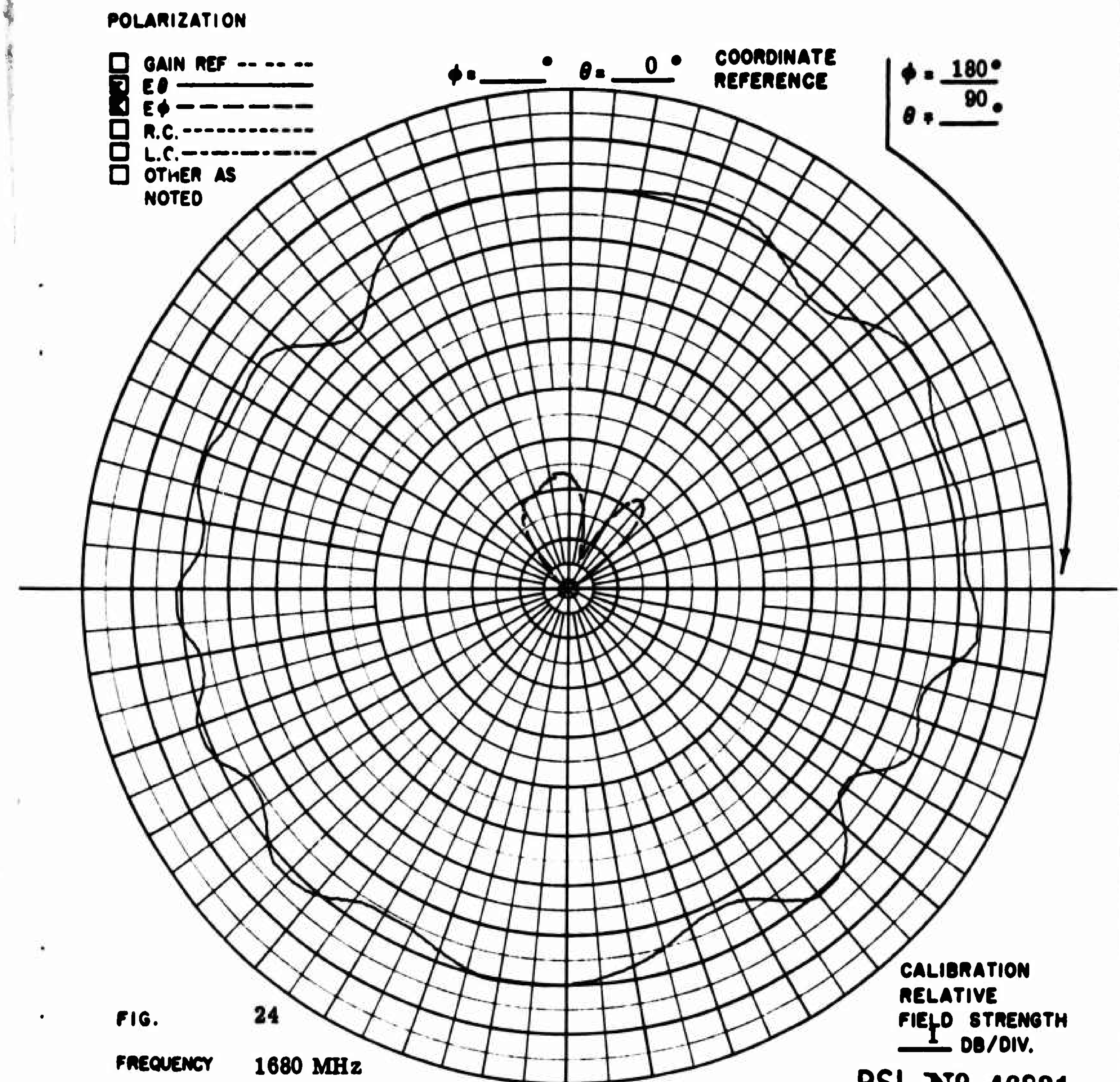
PSL № 46830

FIG. 23

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

FIG. 24

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS

PSL № 46831

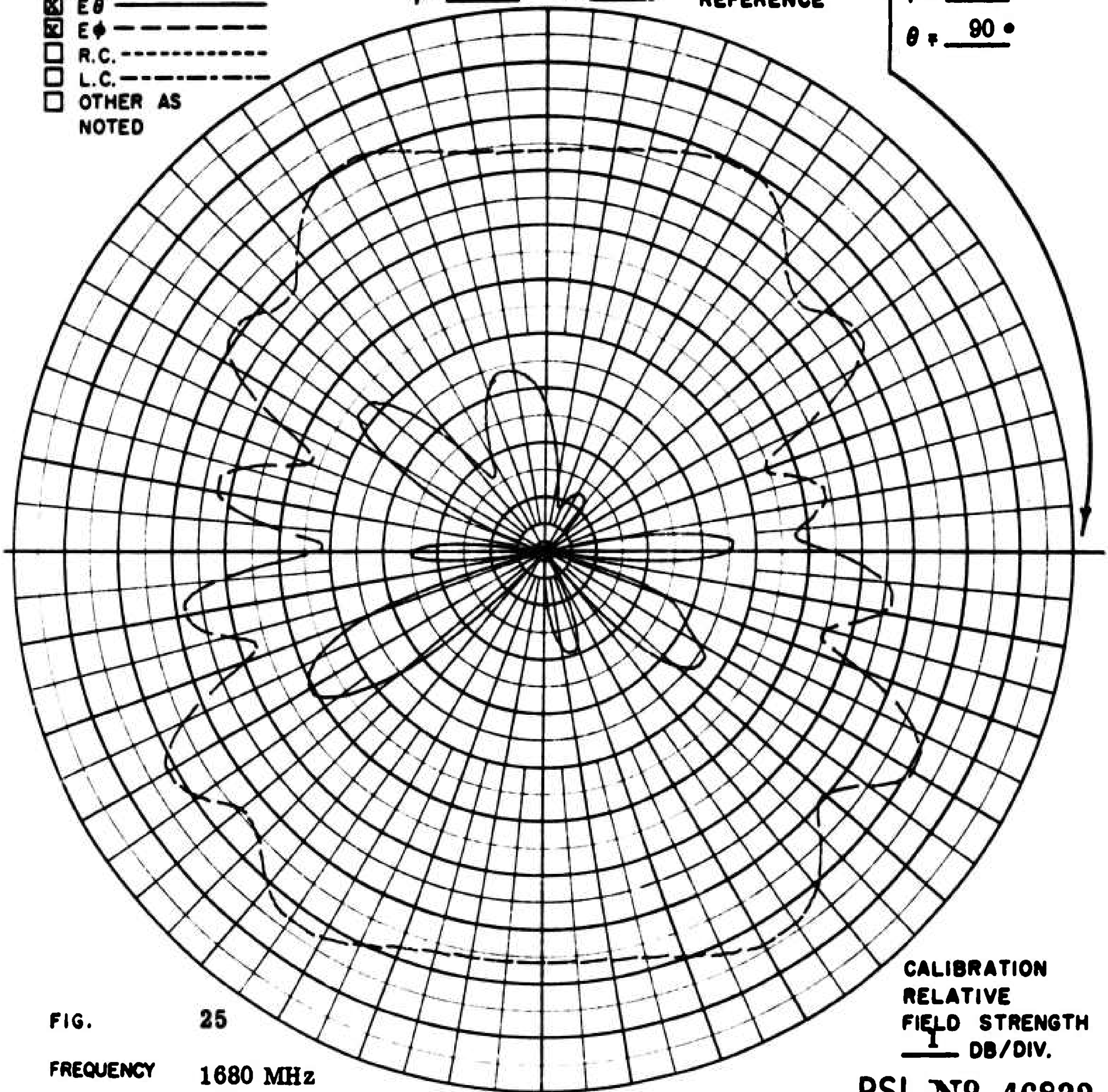
POLARIZATION

- ☐ GAIN REF - - - - - -
- ☒ Eθ ————
- ☒ Eφ — — — — —
- ☐ R.C. - - - - - - - - -
- ☐ L.C. — - — - — -
- ☐ OTHER AS NOTED

φ = _____ ° θ = 0 °

COORDINATE REFERENCE

φ = 270 °
θ = 90 °



CALIBRATION
RELATIVE
FIELD STRENGTH
1 DB/DIV.

PSL № 46832

FIG.	25
FREQUENCY	1680 MHz
ANTENNA	Model 24.006
REMARKS	

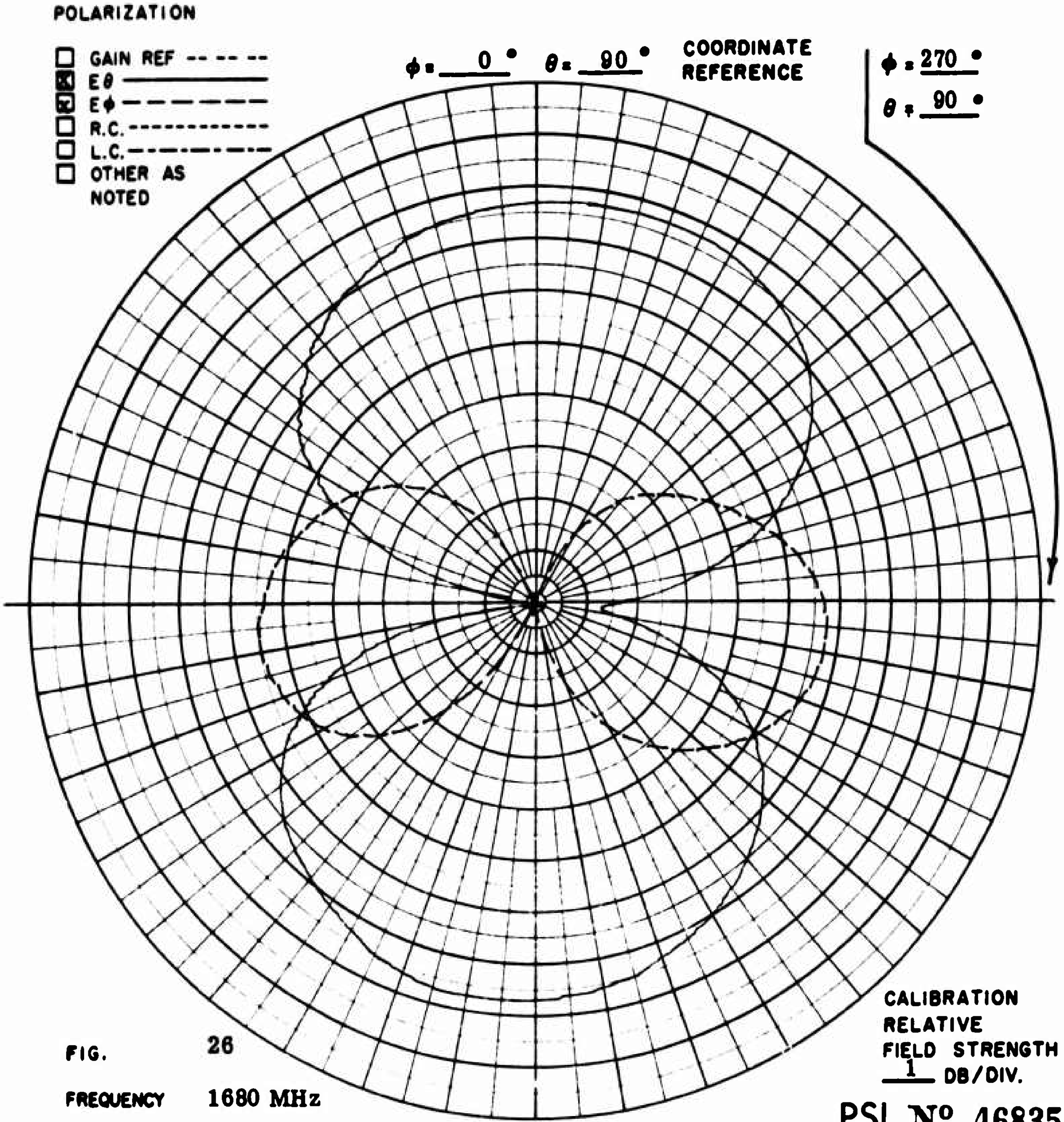


FIG. 26

FREQUENCY 1680 MHz

ANTENNA Model 24.006

REMARKS θ = 90° Plane pattern

PSL № 46835

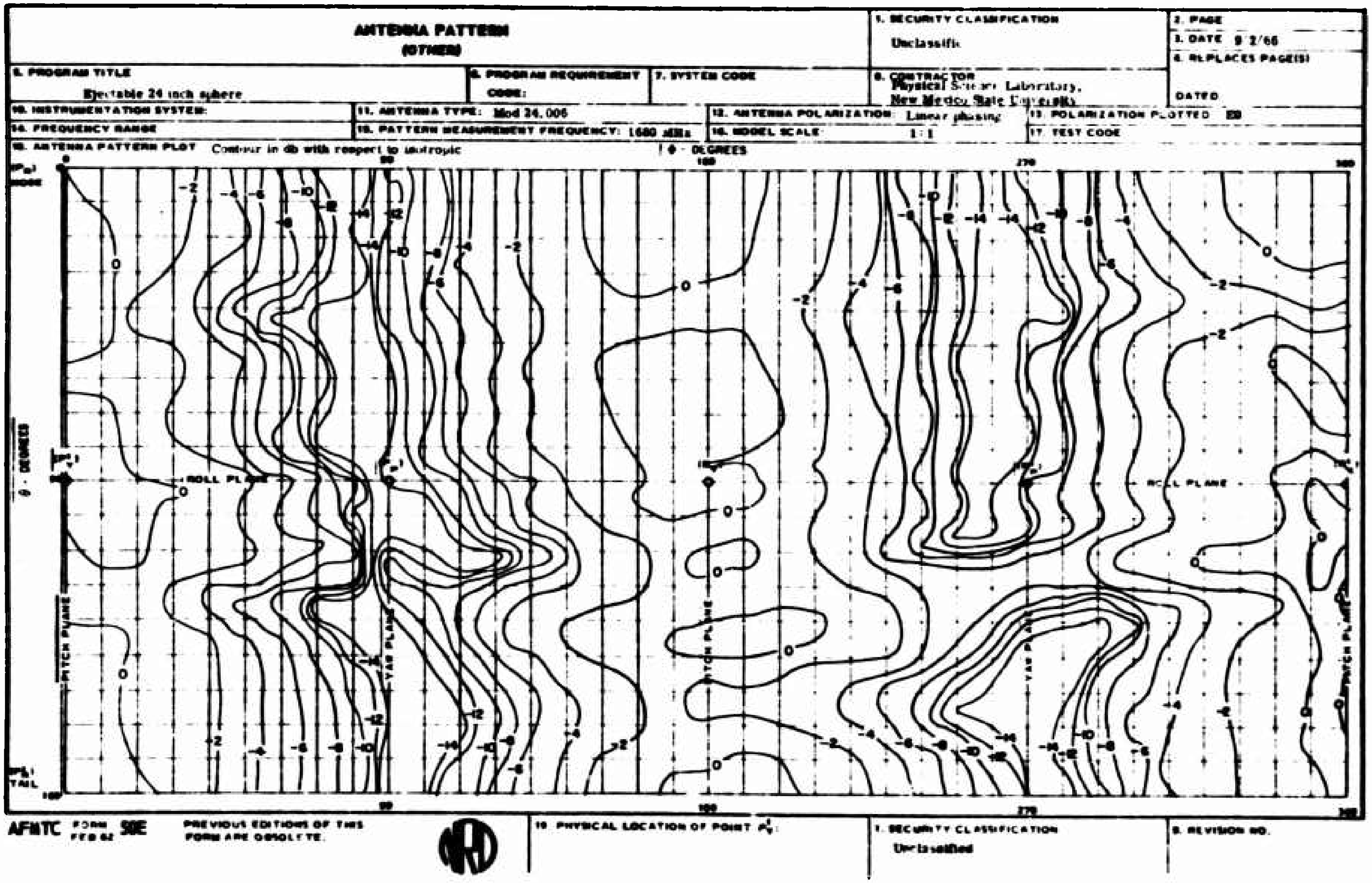


FIG. 27 - POWER CONTOUR PLOT OF MODEL 24.006 ANTENNA, LINEAR E_θ POLARIZATION

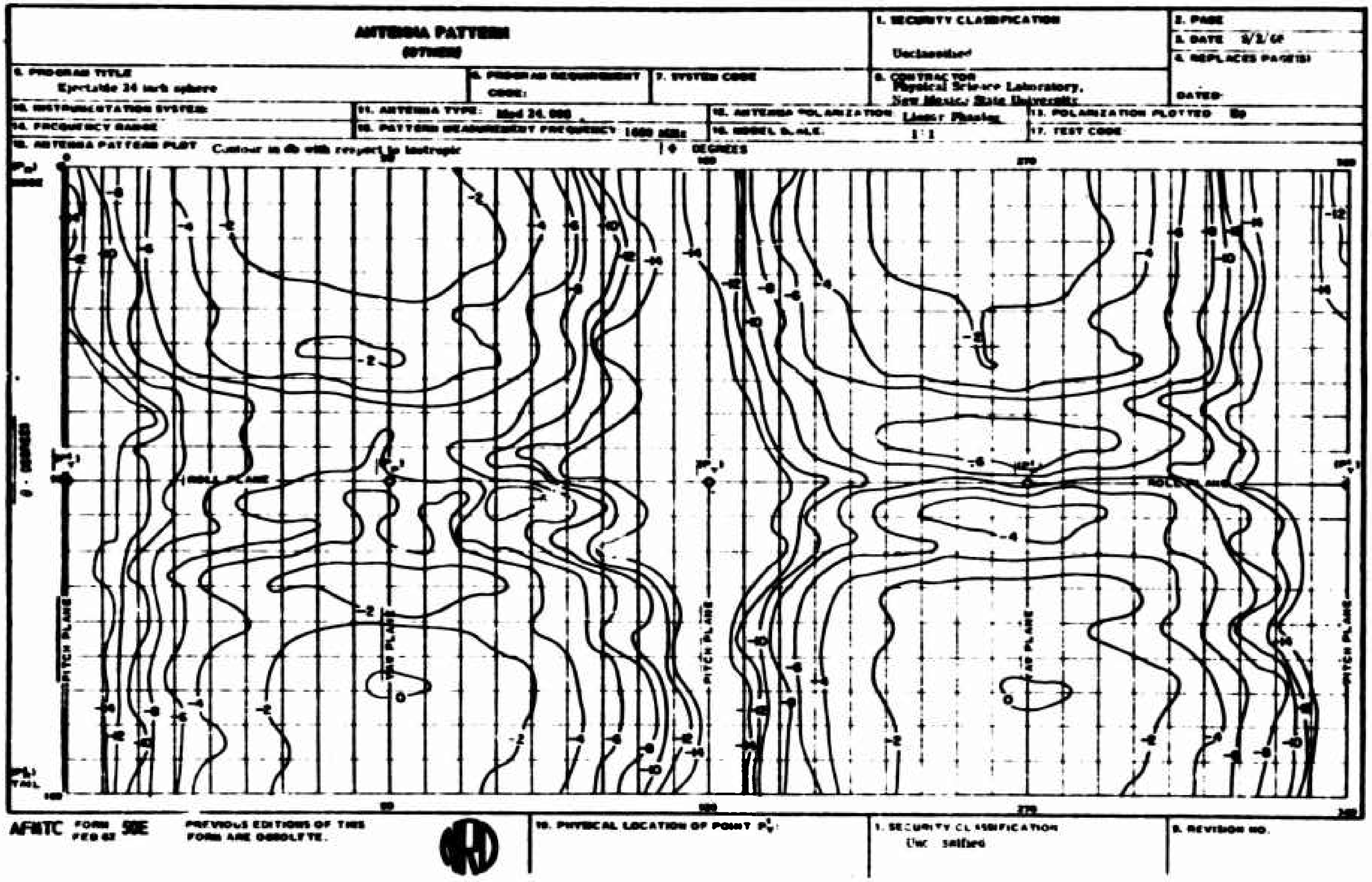


FIG. 28 - POWER CONTOUR PLOT OF MODEL 24.006 ANTENNA, LINEAR E_ϕ POLARIZATION

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Henry, D. G. Haas, H. W. (PD)
Buller, B. T.

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13. ABSTRACT

The PSL Model 24.006 quadraloop antenna was developed as a 1680 MHz telemetry antenna. The antenna is mounted on an ejectable twenty-four inch sphere, which is ejected from an Arcus type rocket. The antenna is designed to fit inside a nylon housing attached to the metal strut of the sphere. The Model 24.006 antenna was tested for radiation pattern, VSWR and mechanical integrity.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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