AD-A045 065 NAVY ELECTRONICS LAB SAN DIEGO CALIF F/G 17/1
TEST RESULTS OF SQS-23/PAIR (AN/SQQ-23) TRANSMITTER AND THE RAY--ETC(U)
AUG 66 H J KLEE
UNCLASSIFIED NEL-TM-1060 NL

1 OF 1
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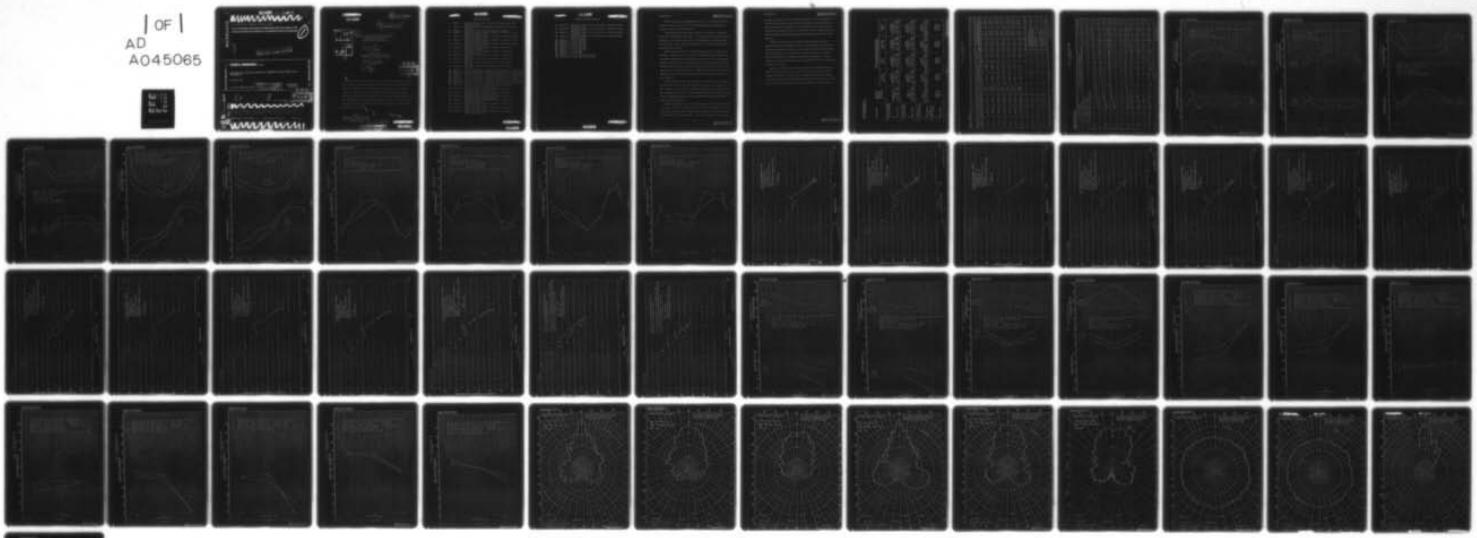

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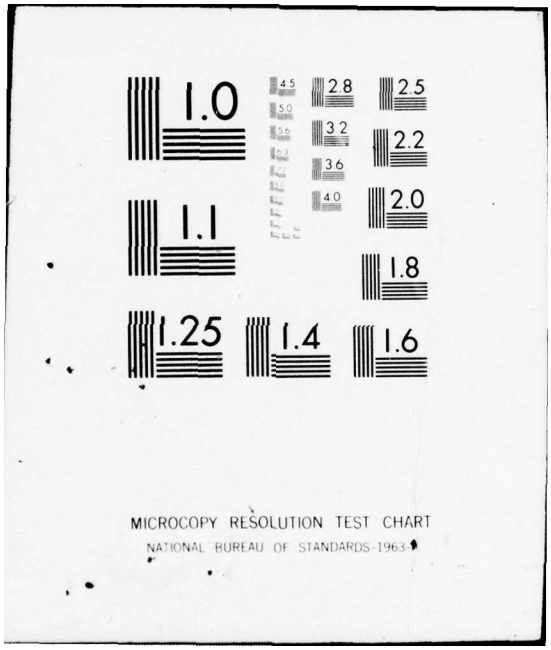
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1.1
1.25
1.4
1.6
1.8
2.0
2.2
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2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

NEL/Technical Memorandum 1060

# TECHNICAL MEMORANDUM TM-1060

TEST RESULTS OF SQS-23/PAIR (AN/SQQ-23) TRANSMITTER AND THE RATHEON TR-197 TRANSDUCER (U)

16 August 1966

H. J. Klee (NEL Code 2140)



S27-20(8573)
NEL J71471

NEL/Technical Memorandum 1060

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UNCLASSIFIED

NEL Technical Memorandum
Number 1060

NEL-TM-1060



# Test Results of SQS-23/PAIR (AN/SQQ-23) Transmitter and the Raytheon TR-197 Transducer.

by

H. J. Klee

Code 2140
U. S. Navy Electronics Laboratory
San Diego, California 92152

16 August 1966

55 p.



This technical memorandum represents a portion of the work being done on NEL Problem J714, AN/SQS-23 Performance and Integration Retrofit (PAIR) Program. It should not be construed as a formal report as its primary intent is to present some of the problems confronting project personnel and some of the preliminary conclusions. While it was originally published in a different form, it is now being included in the technical memorandum series for sake of documentation uniformity and control. Limited outside distribution is intended.



[redacted]

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TABLE OF DRAWINGS

TABLE OF DRAWINGS (Cont'd)

30. Graph 28 - Transmitter plate circuit efficiency vs operating depth, stave #1, 4.5 kc
31. Graph 29 - Transmitter plate circuit efficiency vs operating depth, stave #4, 4.5 kc
32. Graph 30 - Transmitter plate circuit efficiency vs operating depth, stave #1, 5.5 kc
33. Graph 31 - Transmitter plate circuit efficiency vs operating depth, stave #4, 5.5 kc
34. Pattern 1 - 4.5 kc, $7\frac{1}{2}^{o}$, SLT
35. Pattern 2 - 4.5 kc, $15^{o}$, SLT
36. Pattern 3 - 4.5 kc, $30^{o}$, SLT
37. Pattern 4 - 5.5 kc, $7\frac{1}{2}^{o}$, SLT
38. Pattern 5 - 5.5 kc, $15^{o}$, SLT
39. Pattern 6 - 5.5 kc, $30^{o}$, SLT
40. Pattern 7 - 4.5 kc, OMNI
41. Pattern 8 - 5.5 kc, OMNI
42. Pattern 9 - 4.5 kc, $7\frac{1}{2}^{o}$, SLT (vertical)
43. Pattern 10- 5.5 kc, $7\frac{1}{2}^{o}$, SLT (vertical)

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Active testing of the SQS-23G/PAIR transmitter with Raytheon TR-197 transducer has been completed. This memorandum presents a preliminary summary of the results of the tests.

In all graphs and tables present herein, A + B refers to the transmitter drive and output connections. A + B means that transmitter A drives elements 1, 2, 3, 8 and 9 of a stave while transmitter B drives elements 4, 5, 6 and 7. In the A only, B only or the A or B mode, one transmitter drives the entire stave.

Graph 1 shows source level for all operating modes as a function of frequency. Fundamental source levels are very close to specified levels, but harmonic distortion caused harmonic source levels that are high enough (graphs 12 through 19) to be detrimental to VIS and sonic guided torpedoes. A major portion of these harmonics are generated within the "Class C" output stage of the SQS-23G transmitter. Significant reduction of the harmonic output could only be accomplished by redesign of the final stages of this power amplifier.

Graphs 2 through 7 show the variation in transducer element impedance for the TR-197 under normal PAIR operating conditions. The magnitude of the impedance varies from 20Ω to 130Ω with phase angles from $-90^{\circ}$ to $+30^{\circ}$. These highly variable reactive loads limit the maximum source level by high screen and plate dissipations in the transmitter output stage under the above operating conditions.

Graphs 8 through 11 present transmitter plate circuit dissipation and efficiency. Plate, screen grid, and drive voltage were adjusted to obtain the maximum possible source level consistant with the maximum power dissipation ratings for the output tubes. The output transformer was included



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as part of the plate circuit for these measurements. The dissipation in this transformer must be subtracted from the plate circuit dissipation to obtain true element dissipation. At some frequencies the plate circuit dissipation exceeds the limit set at 520 watts. This is permissible since for most PAIR operating modes the average dissipation will be less than 520 watts.

Graphs 20 through 31 present the previously mentioned data as a function of operating transducer depth. At the one-half foot depth considerable cavitation was visible in the acoustic waveform and the maximum power dissipation in the output tubes was greatly exceeded. Because of the varying depth of the transducer during normal operation, a careful look at the long term reliability of the transmitter under these operating conditions is needed.

Patterns 1 through 6 are typical patterns of the SQS-23G/PAIR transmitter with a TR-197 transducer. The relatively high side lobe levels support the previous conclusion that the beamforming delays in the TCU are not proper to form the PAIR specified transmit beam, and that transmit beams will also be a function of the active transducer type installed.



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| Equipment | SQS-23G Maximum Ratings (1 unit) | PAIR Operating Requirements ( with TR-197 transducer) | | | |
|---|---|---|---|---|---|
| | | A+B 300° RDT | A+B OMNI | A or B 300° RDT | A or B OMNI |
| 1. High voltage M.G.s(PU-485) | | 2 units | 2 units | 2 units | 2 units |
| E | 2700/2450 v. | 2530/2500 v. | 2530/2500 v. | 2530/2500 v. | 2530/2500 v. |
| I | 16.0 A. | 4.7 A. | 17.2 A. | 4.7 A. | 15.8 A. |
| Duty cycle | 0.9 sec. ON 11.1 sec. OFF | 5.7 sec. ON 16.0 sec. OFF | 0.32 sec. ON 4.0 sec. OFF | 5.7 sec. ON 16.0 sec. OFF | 0.32 sec. ON 4.0 sec. OFF |
| 2. Screen grid M.G.s(PU-519) | | 1 unit | 1 unit | 1 unit | 1 unit |
| E | 875 v. | 530/500 v. | 530/500 v. | 530/500 v. | 530/500 v. |
| I | 2.00 A. | 1.25 A. | 3.43 A. | 1.42 A. | 3.12 A. |
| Duty cycle | 0.9 sec. ON 11.1 sec. OFF | 5.7 sec. ON 16.0 sec. OFF | 0.32 sec. ON 4.0 sec. OFF | 5.7 sec. ON 16.0 sec. OFF | 0.32 sec. ON 4.0 sec. OFF |
| 3. 325 volt M.G.s(PU-479) | | 1 unit | 1 unit | 1 unit | 1 unit |
| E | 325 v. | 325 v. | 325 v. | 325 v. | 325 v. |
| I | 3.0 A-0.9 sec. | 3.25A-5.7 sec. | 4.68A-.32 sec. | 1.73A-5.7 sec. | 2.35A-.32 sec. |
| Duty cycle | 1.0 A-11.1sec. | 2.66A-16 sec. | 2.66A-4.0 sec. | 1.33A-16 sec. | 1.33A-4.0 sec. |
| 4. 300/500 v. Bias supply | | | | | |
| E | 300 v. | 300 v. | 300 v. | 300 v. | 300 v. |
| I | 0.25 A. | 0.21A. | 0.57A. | 0.11A. | 0.28A. |
| Duty cycle | 12 % | 25 % | 7.4 % | 25 % | 7.4 % |

Table I

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| Frequency (Khz) | DC Input Power (Kw) | AC Output Power (Kw) | Acoustic Power (Kw) | Directivity Index Measured | Directivity Index Theor. | Source Level (db) | Efficiency (per cent) Amplifier | Transducer | Overall |
|---|---|---|---|---|---|---|---|---|---|
| 4.3 | 18.1 | 7.8 | 4.17<br>3.6 | 25.8 | 24.6 | 133.6 | 43.0 | 53.5<br>46.5 | 23.0<br>20.0 |
| 4.5 | 22.28 | 8.06 | 5.39<br>4.36 | 26.0 | 25.0 | 134.9 | 36.0 | 62.6<br>54.0 | 22.5<br>19.5 |
| 4.7 | 23.48 | 8.95 | 5.50<br>4.36 | 26.0 | 25.4 | 135.0 | 38.0 | 61.5<br>48.7 | 23.4<br>18.6 |
| 5.0 | 23.53 | 8.38 | 5.63<br>4.67 | 26.0 | 25.9 | 135.1 | 35.6 | 67.2<br>55.0 | 23.9<br>19.7 |
| 5.3 | 23.21 | 11.56 | 5.76<br>5.01 | 26.4 | 26.3 | 135.6 | 49.8 | 47.8<br>43.5 | 24.8<br>21.6 |
| 5.5 | 20.76 | 12.15 | 5.76<br>4.9 | 26.5 | 26.7 | 135.7 | 63.5 | 43.8<br>37.0 | 27.8<br>23.4 |
| 5.7 | 18.57 | 10.18 | 6.31<br>5.52 | 26.9 | 27.0 | 136.5 | 54.5 | 61.0<br>54.0 | 33.3<br>29.5 |

Tabulated Data
SQS-23G/PAIR-Transmitter
TR-197 Transducer
Mode A+B
8/8/66

$E_{bb}$ = 2500 volts
$E_{g2}$ = 500 volts
Drive to Trans. = 0.14 vrms

Table II

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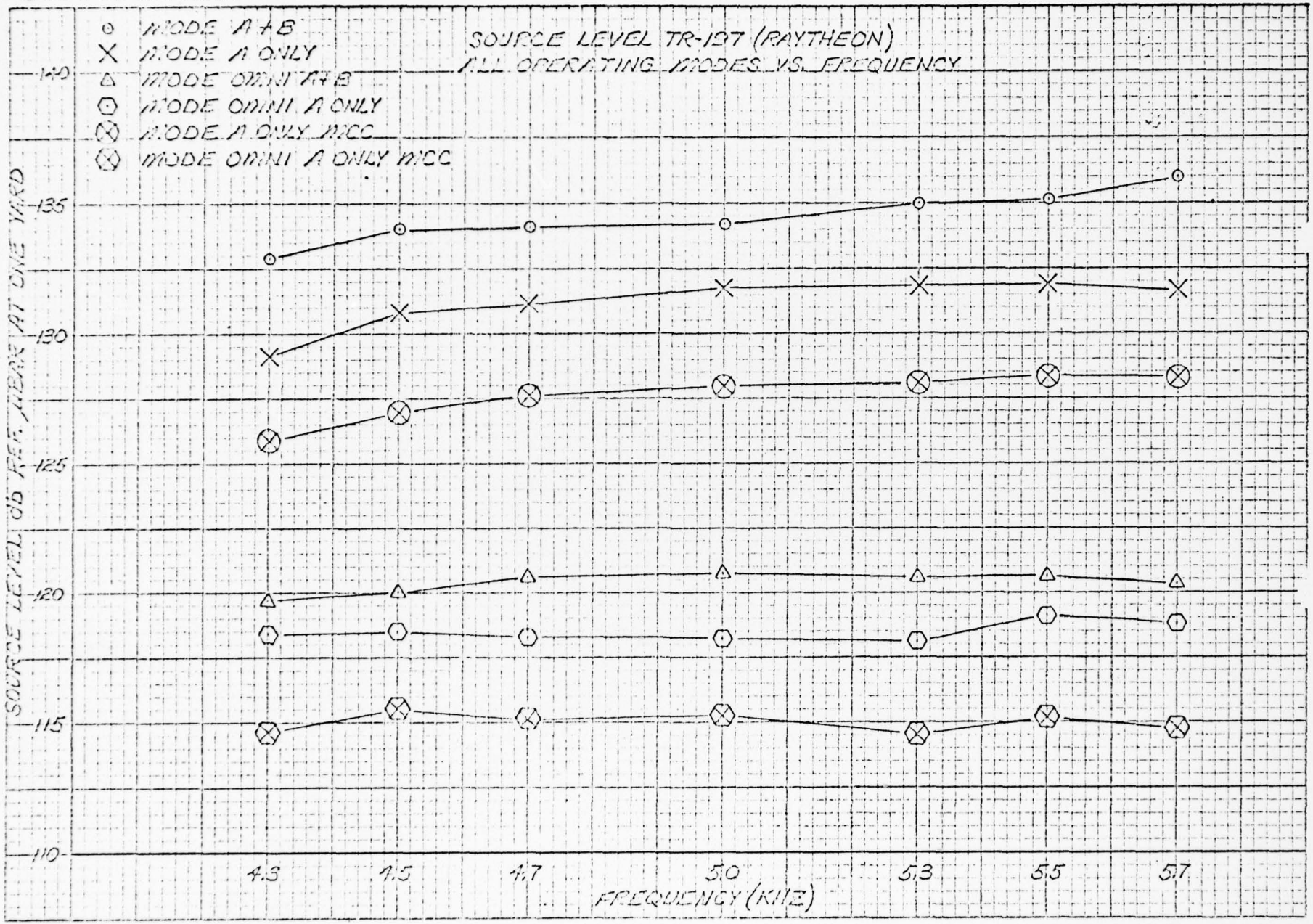


Graph 1

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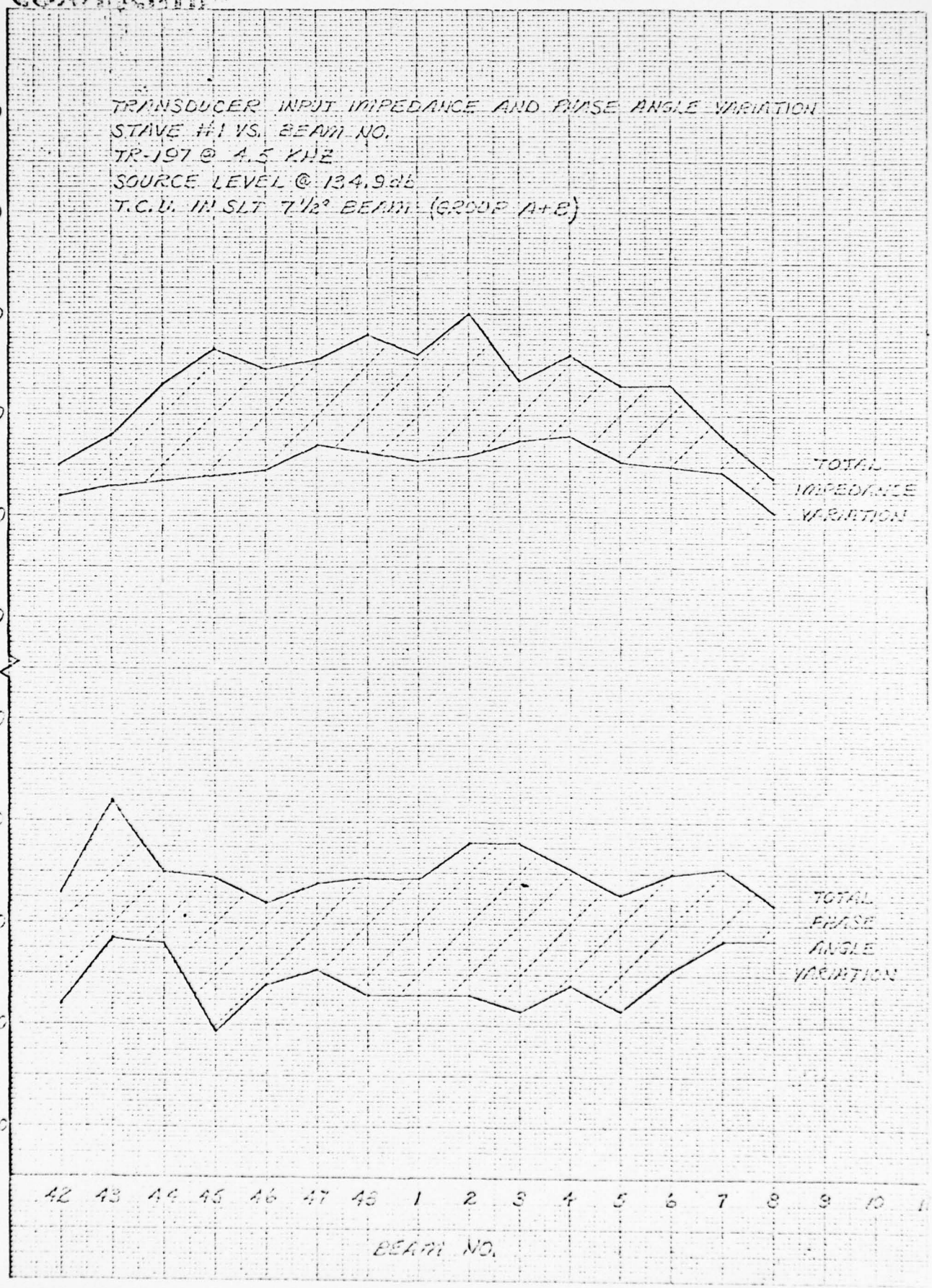
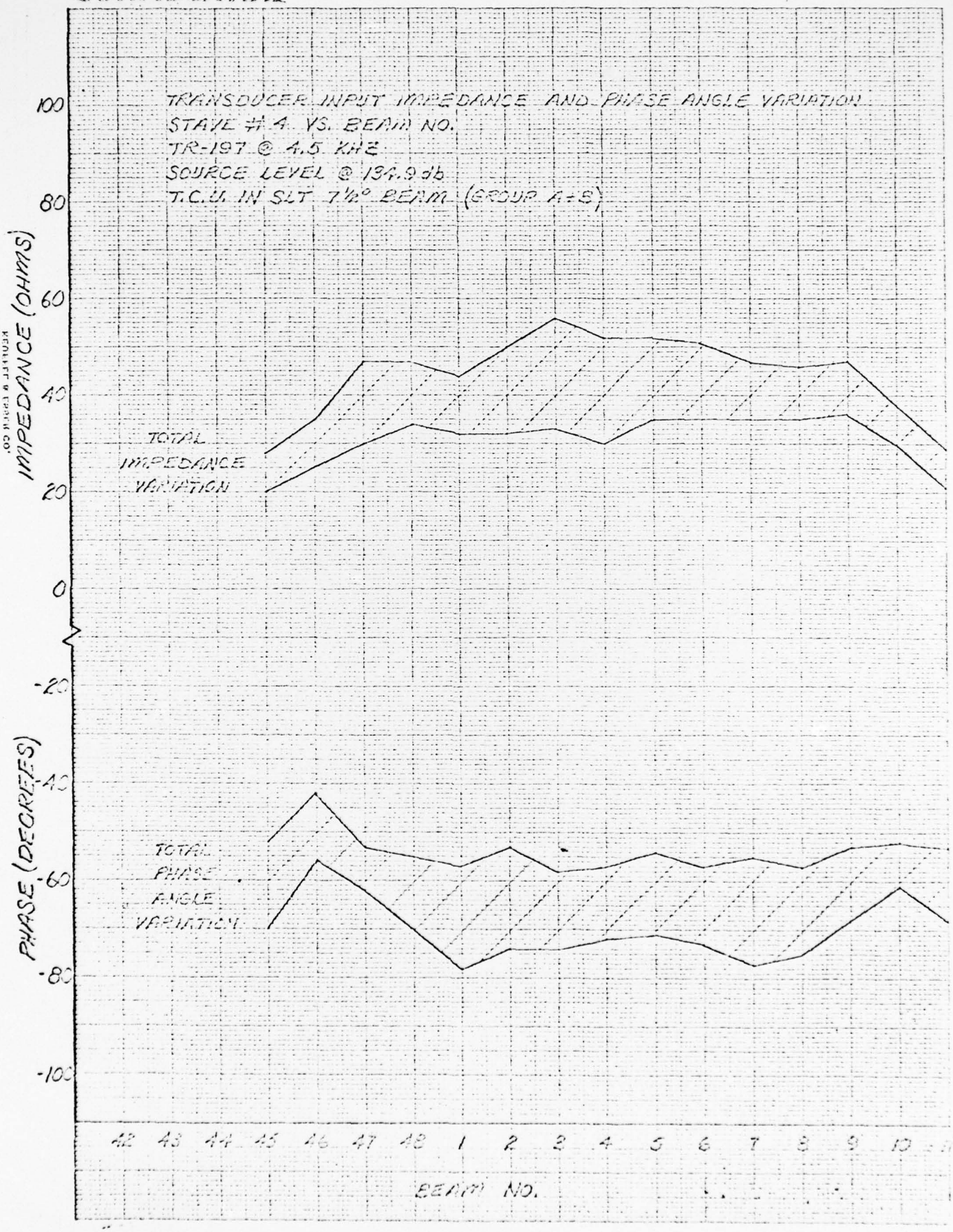
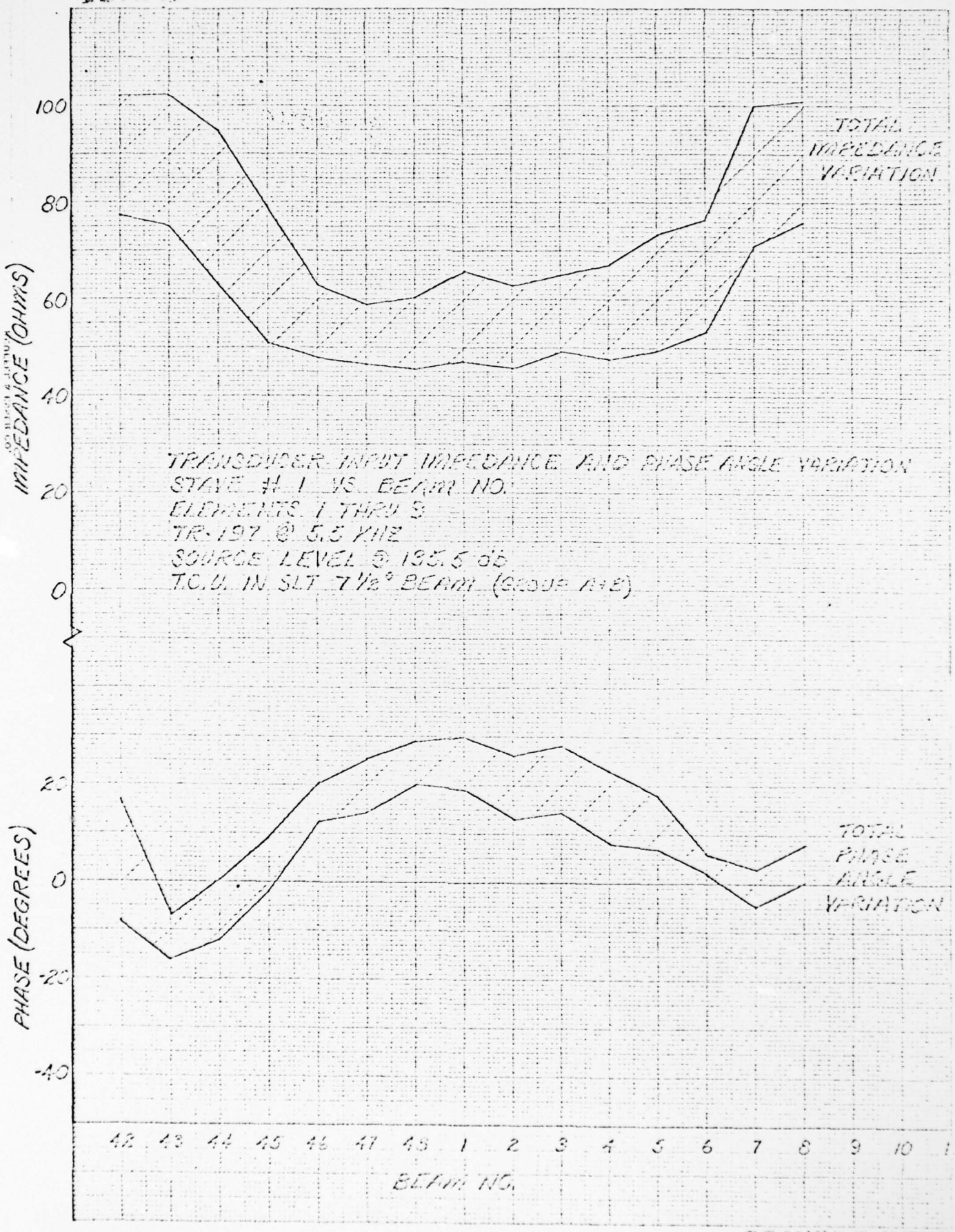
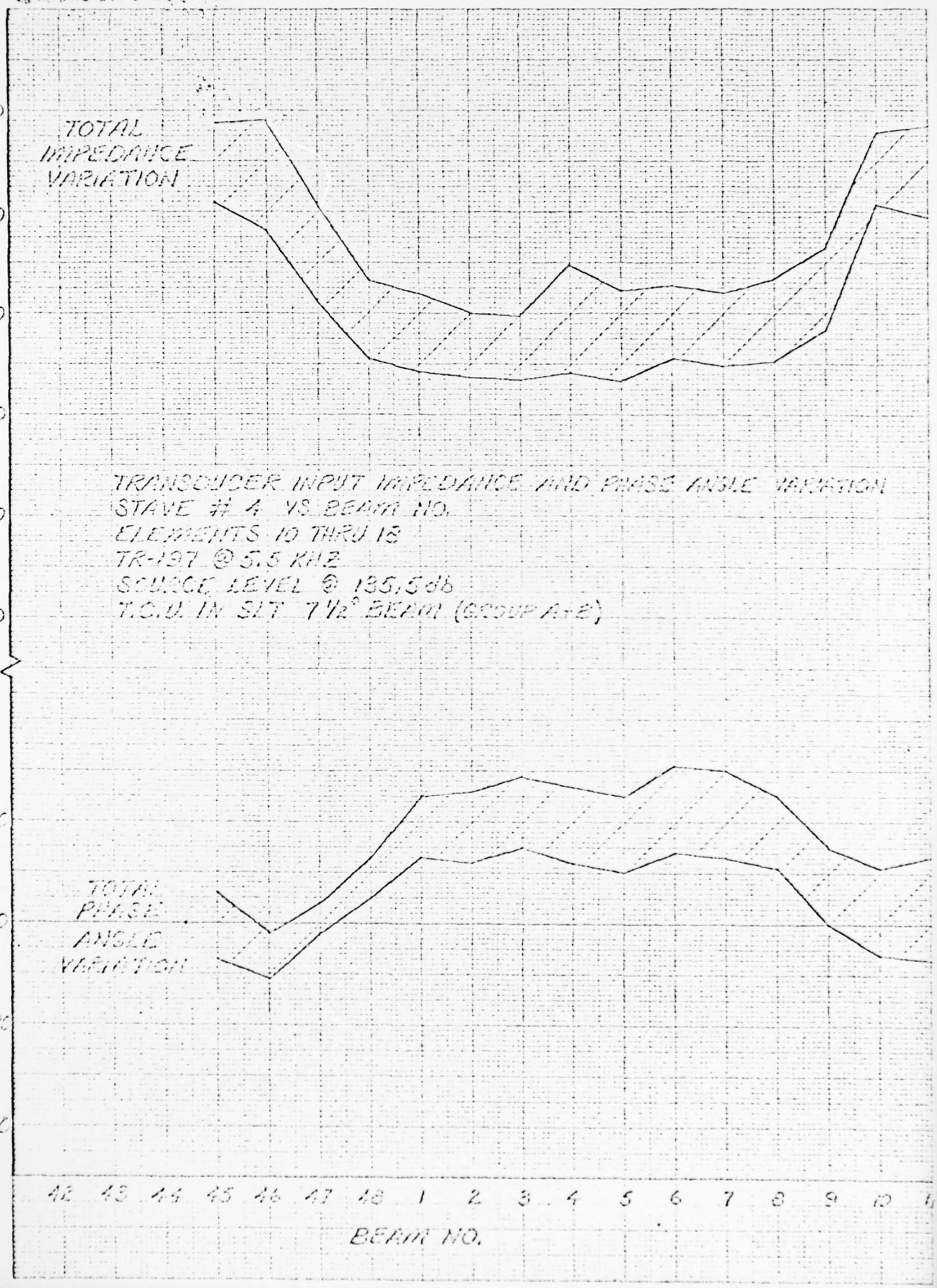



Graph 2




Graph 3






Graph 5

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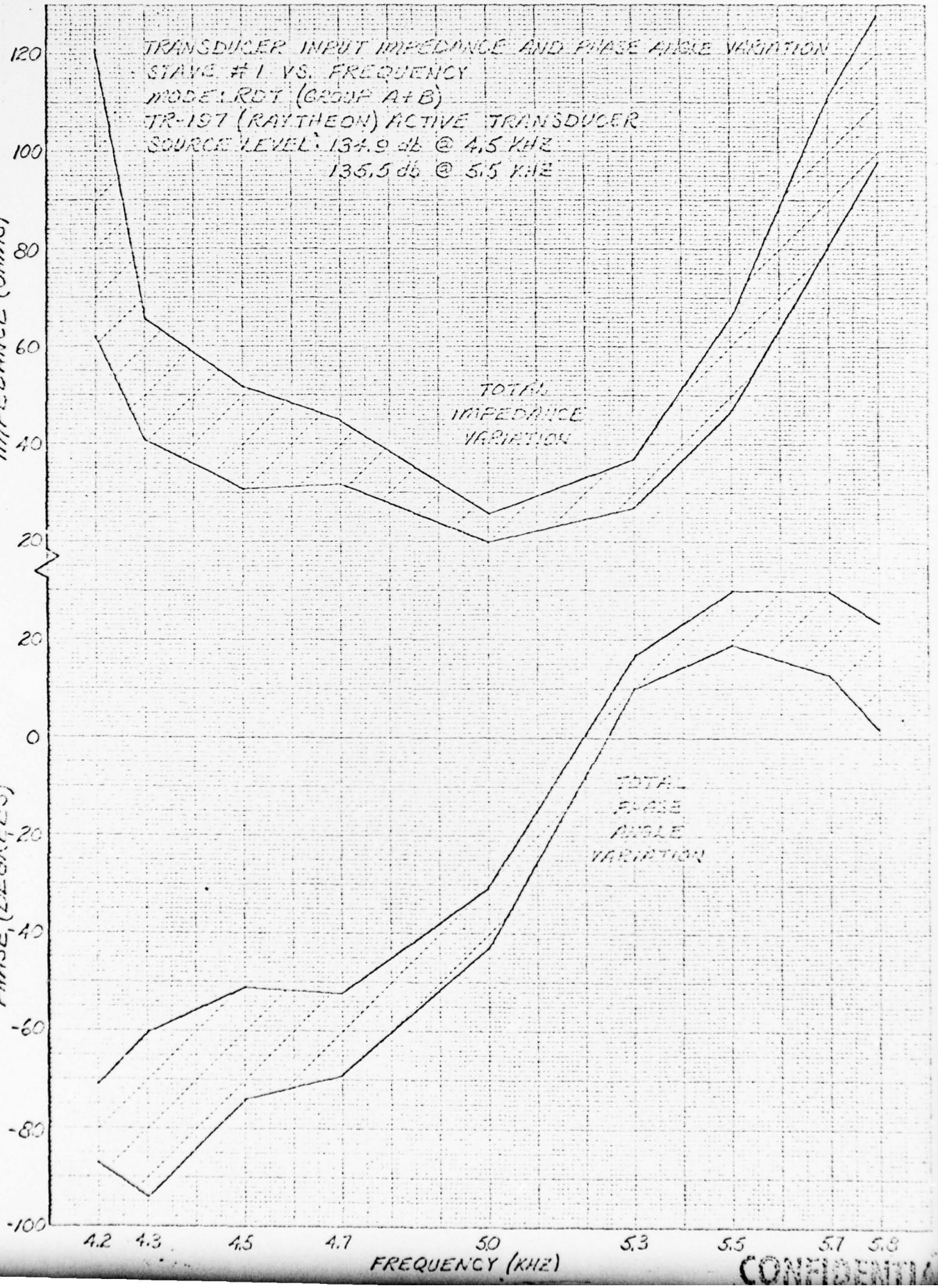


Graph 6

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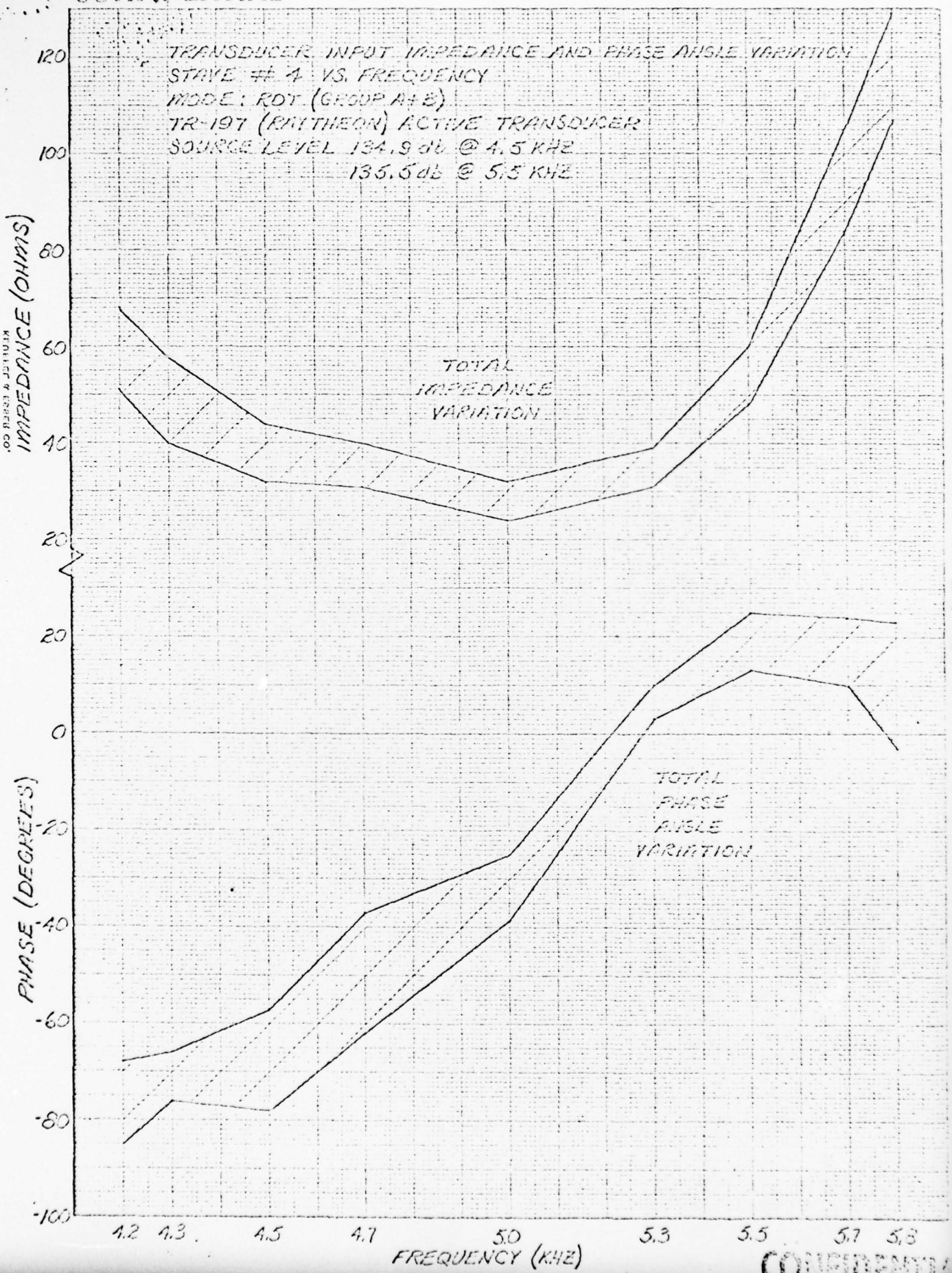
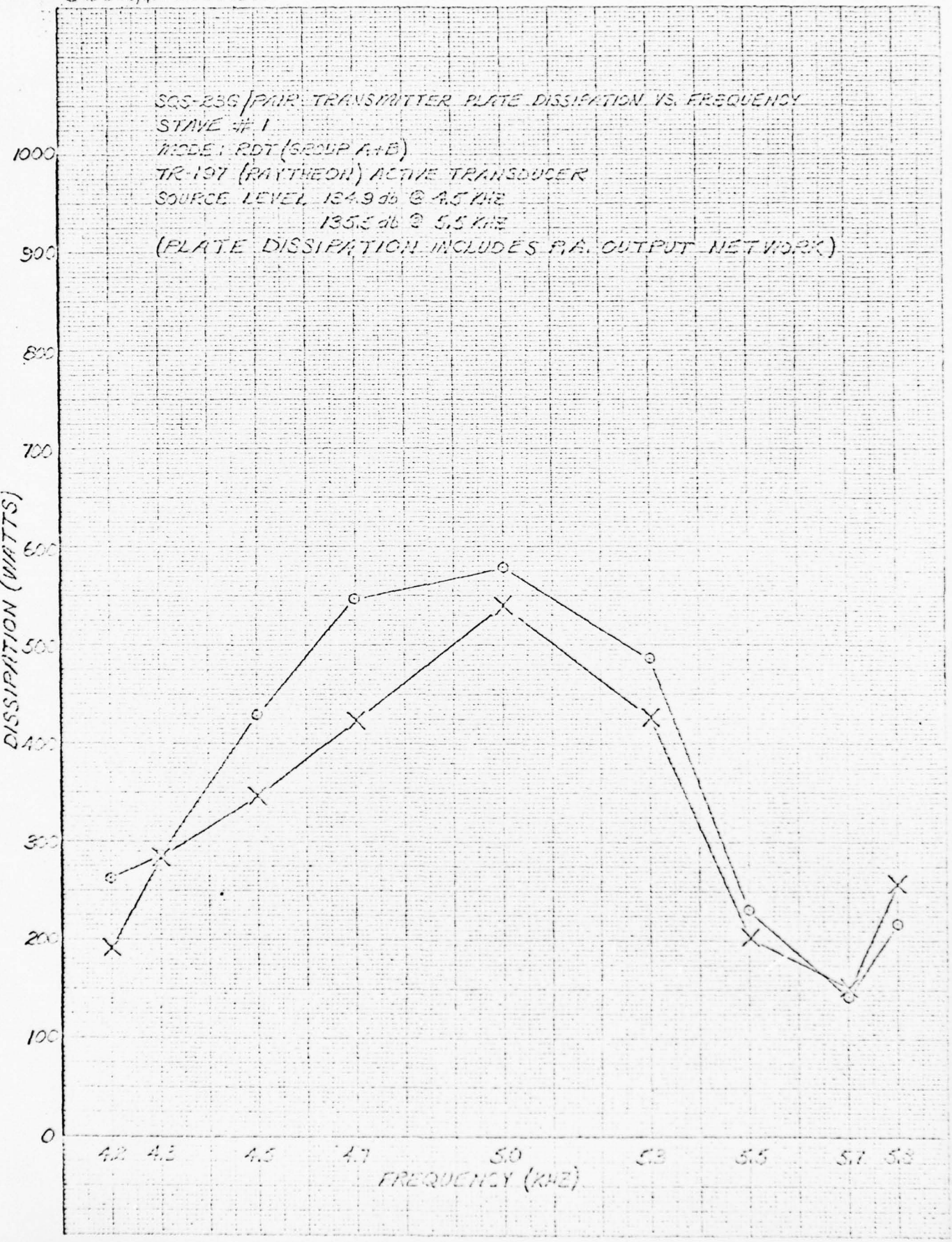

TRANSDUCER INPUT IMPEDANCE AND PHASE ANGLE VARIATION
STAVE # 4 VS. FREQUENCY
MODE: ROT (GROUP A+B)
TR-197 (RAYTHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.9 db @ 4.5 KHZ
135.5 db @ 5.3 KHZ
TOTAL IMPEDANCE VARIATION
TOTAL PHASE ANGLE VARIATION
IMPEDANCE (OHMS)
PHASE (DEGREES)
FREQUENCY (KHZ)
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
4.2
4.3
4.5
4.7
5.0
5.3
5.5
5.7
5.8

Graph 7


SQS-23G (PAIR) TRANSMITTER PLATE DISSIPATION VS. FREQUENCY
STAVE # 1
MODE: RDT (GROUP A+B)
TR-197 (RAYTHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.9 db @ 4.5 KHZ
135.3 db @ 5.5 KHZ
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)
DISSIPATION (WATTS)
1000
900
800
700
600
500
400
300
200
100
0
4.2
4.3
4.5
4.7
5.0
5.3
5.5
5.7
5.8
FREQUENCY (KHZ)

Graph 8

SQS-23 S/BAR TRANSMITTER PLATE DISSIPATION VS. FREQUENCY
STAVE # 4
MODE: ROT (GROUP A+B)
TR-197 (RAYTHEON) ACTIVE TRANSDUCER
SOURCE LEVEL 134.9 db @ 4.5 KHZ
135.5 db @ 5.5 KHZ
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)

DISSIPATION (WATTS)

1000
900
800
700
600
500
400
300
200
100
0

4.2 4.3 4.5 4.7 5.0 5.3 5.5 5.7 5.8

FREQUENCY (KHZ)

Graph 9

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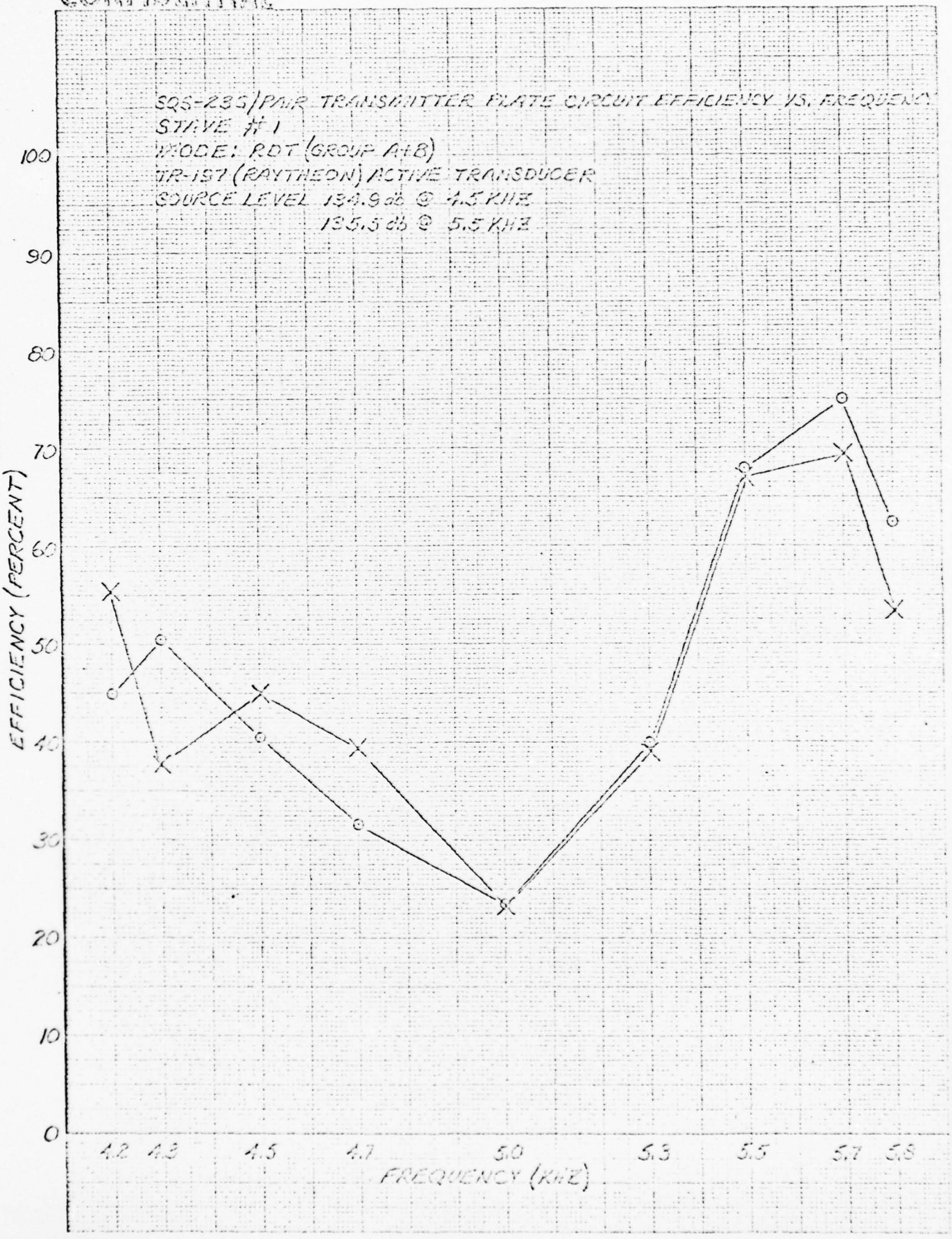
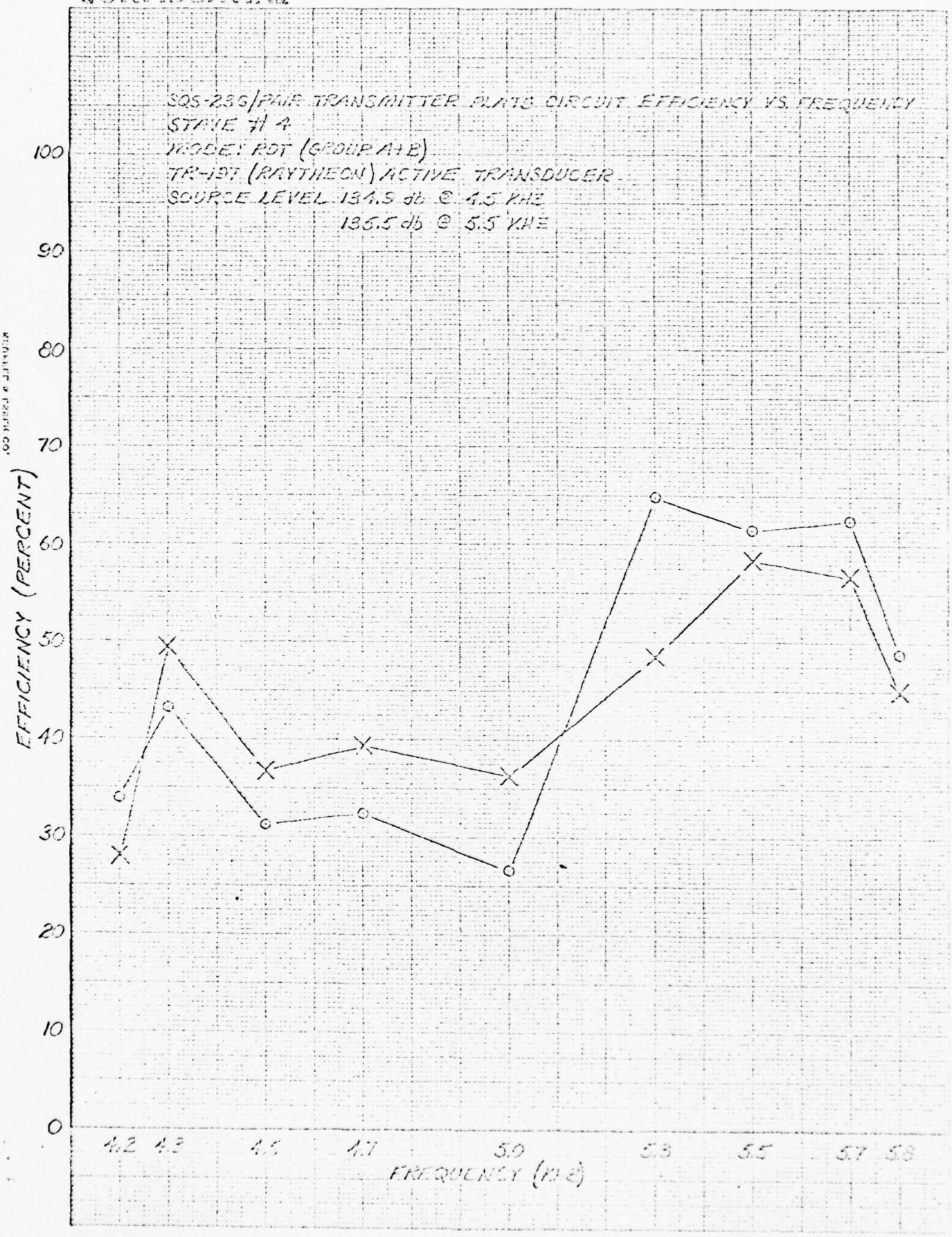
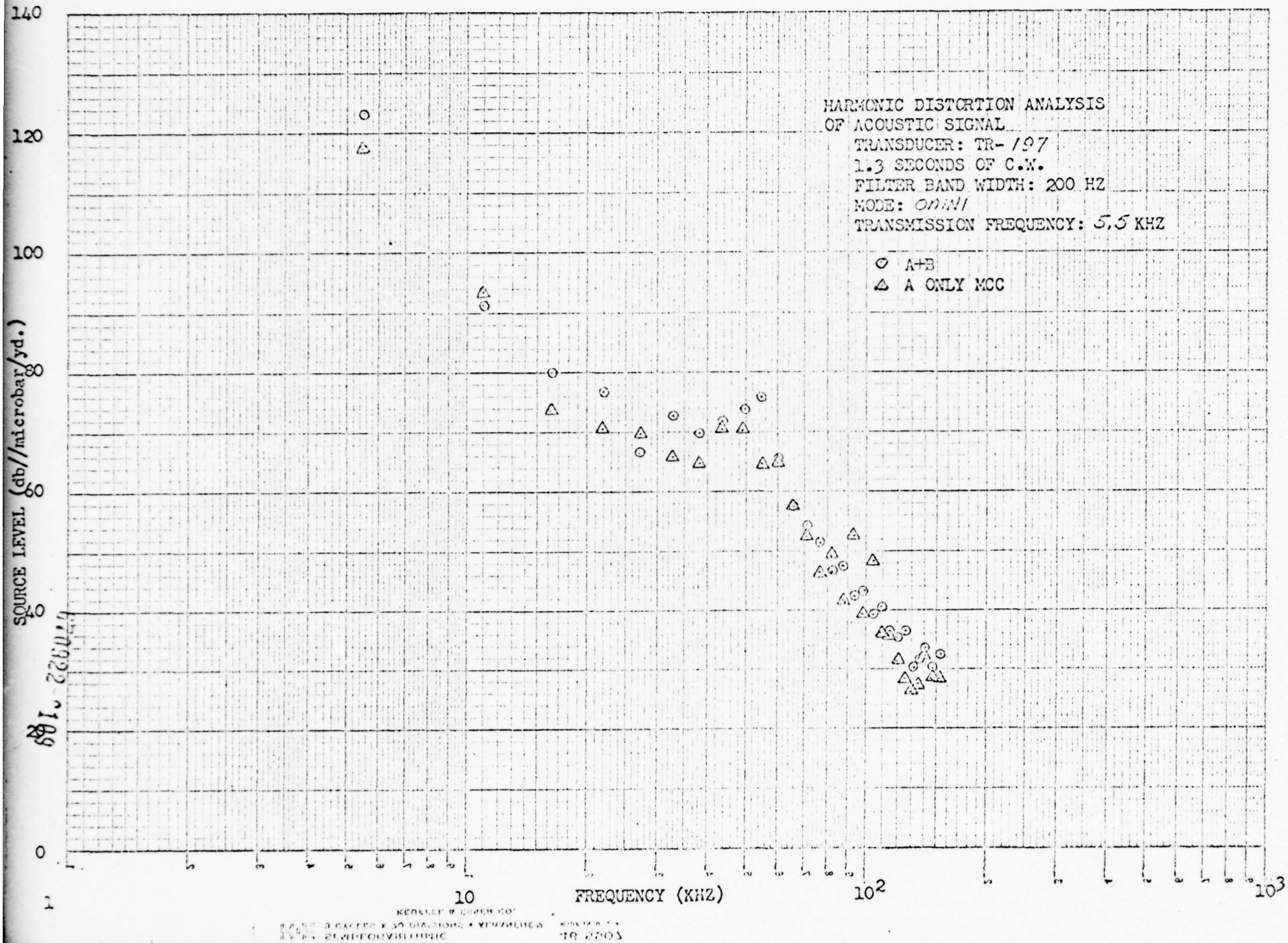



Graph 10

CONFIDENTIAL




Graph 11


HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR-197
1.3 SECONDS OF C.W.
FILTER BAND WIDTH: 200 HZ
MODE: OMNI
TRANSMISSION FREQUENCY: 5.5 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
140
120
100
80
60
40
0
1
10
FREQUENCY (KHZ)
10²
10³

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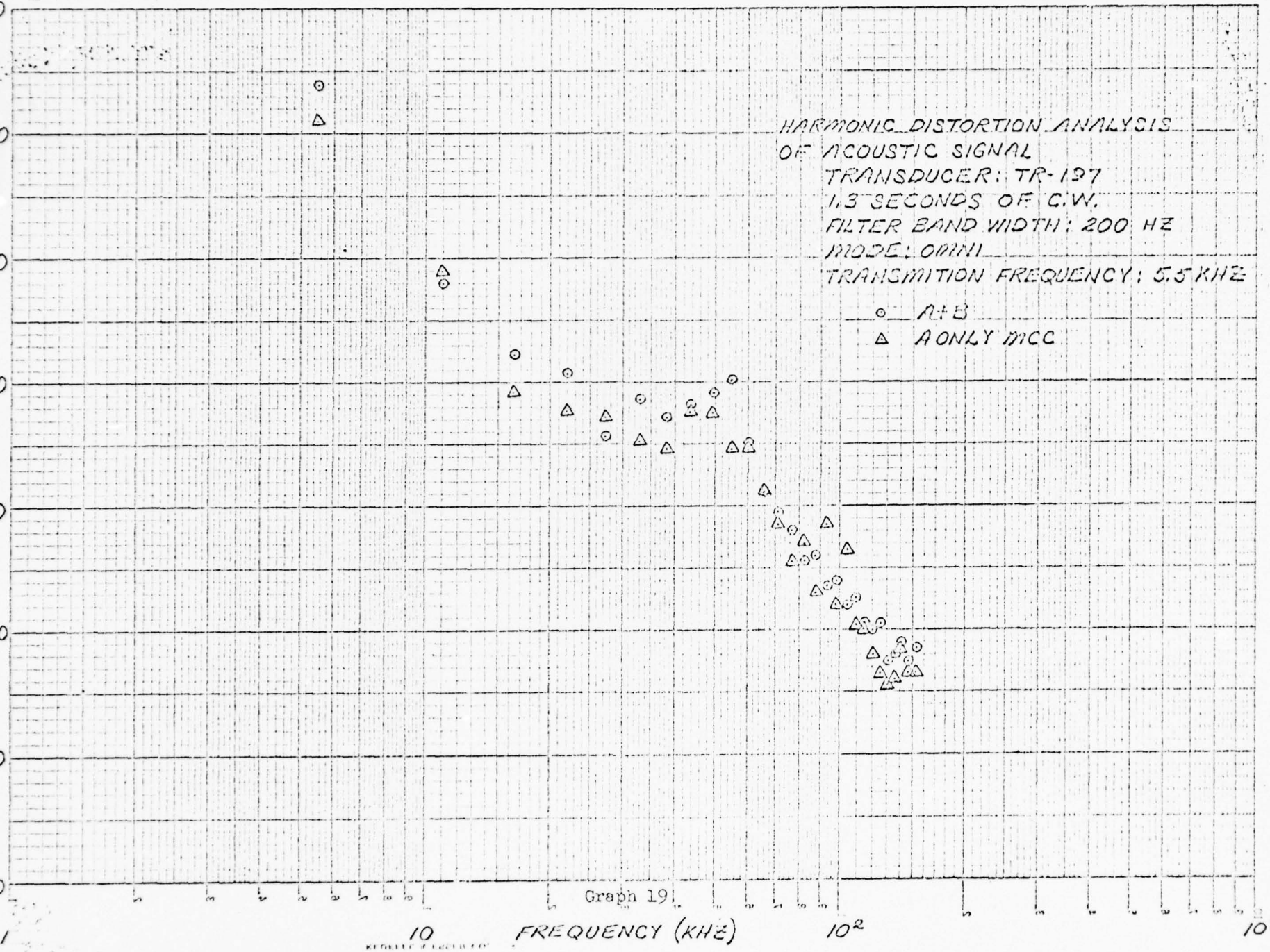


Graph 19

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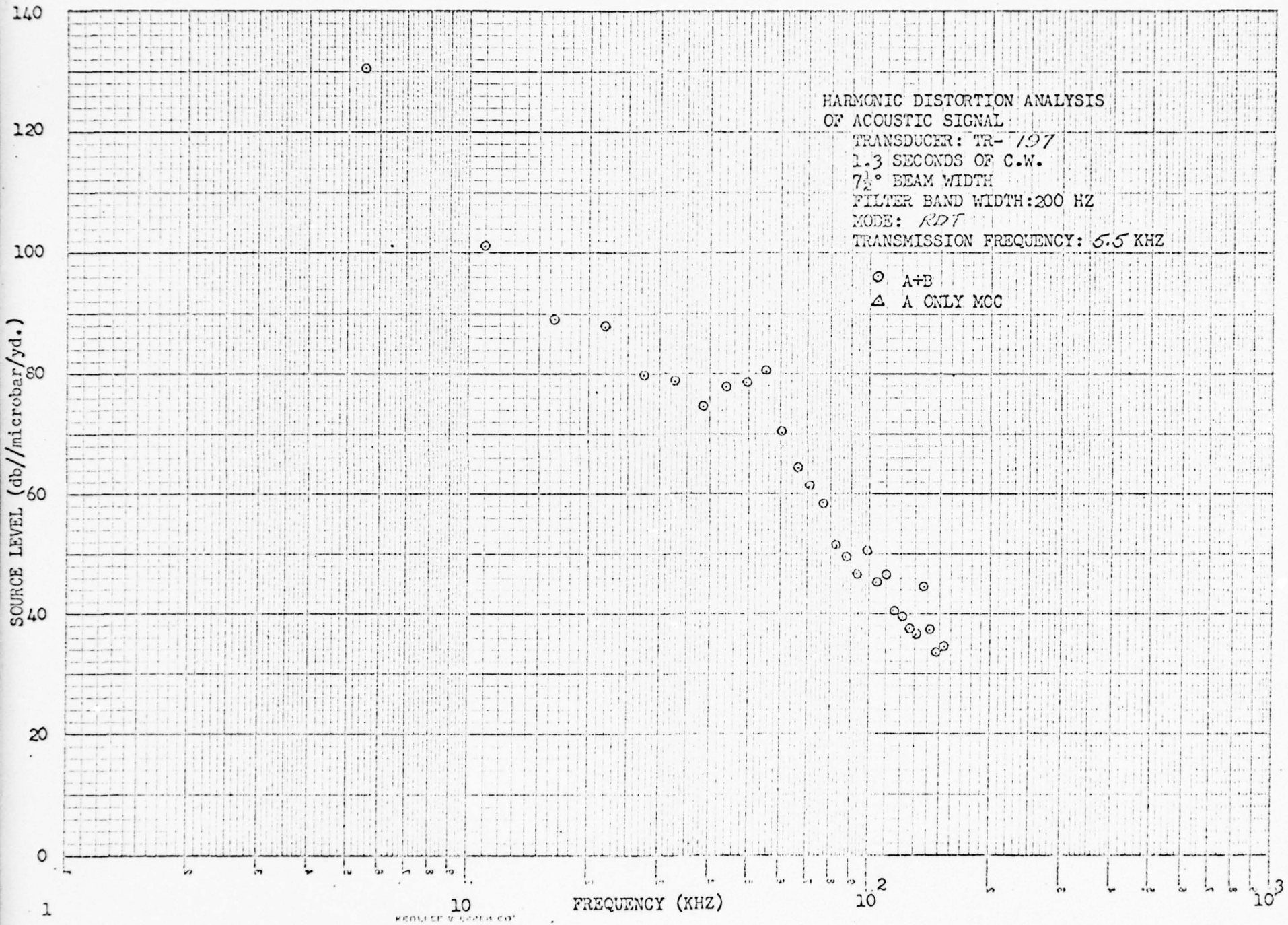
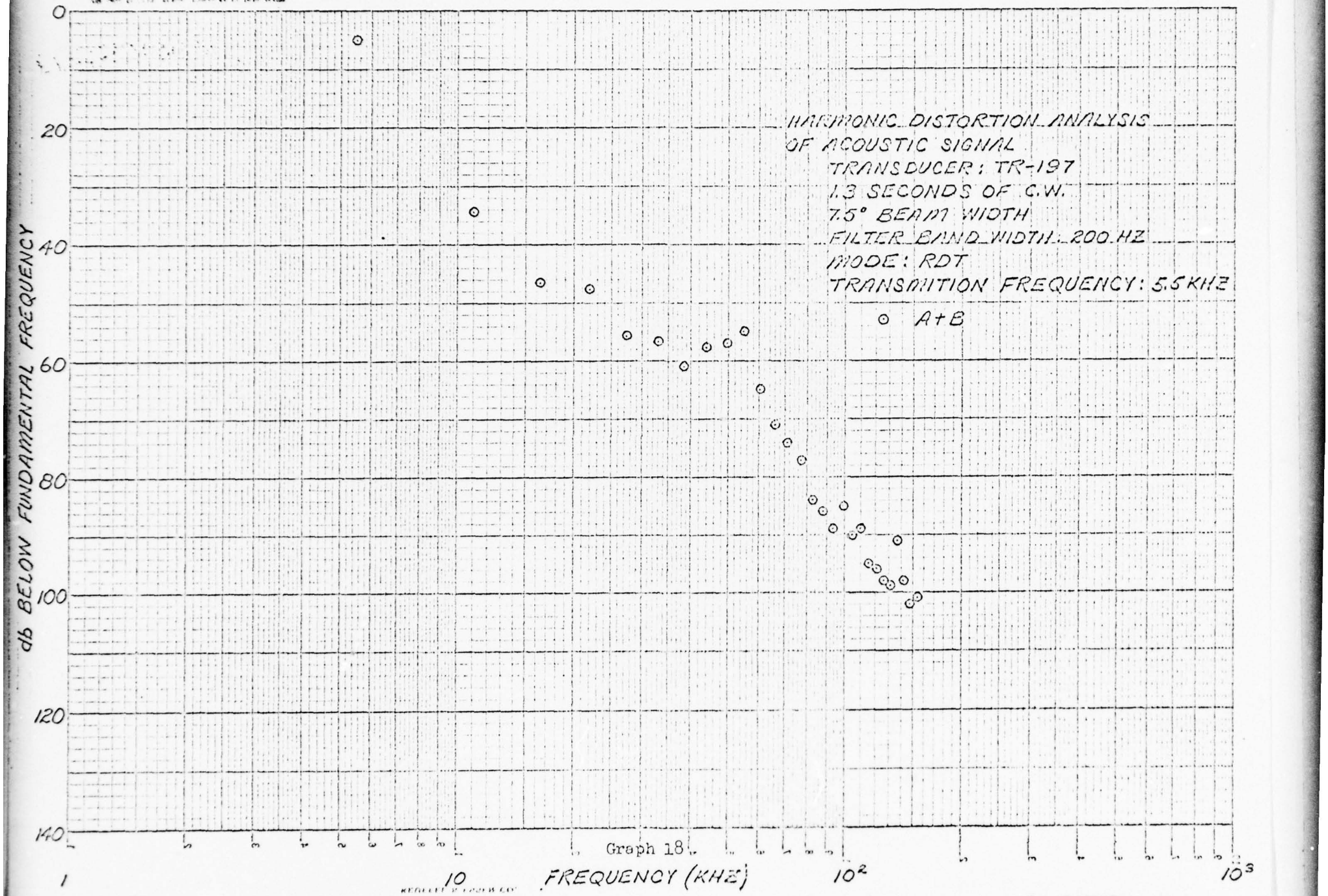

HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR- 197
1.3 SECONDS OF C.W.
7½° BEAM WIDTH
FILTER BAND WIDTH:200 HZ
MODE: RDT
TRANSMISSION FREQUENCY: 6.5 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
140
120
100
80
60
40
20
0
1
10
10^2
10^3
FREQUENCY (KHZ)

CONFIDENTIAL




Graph 18

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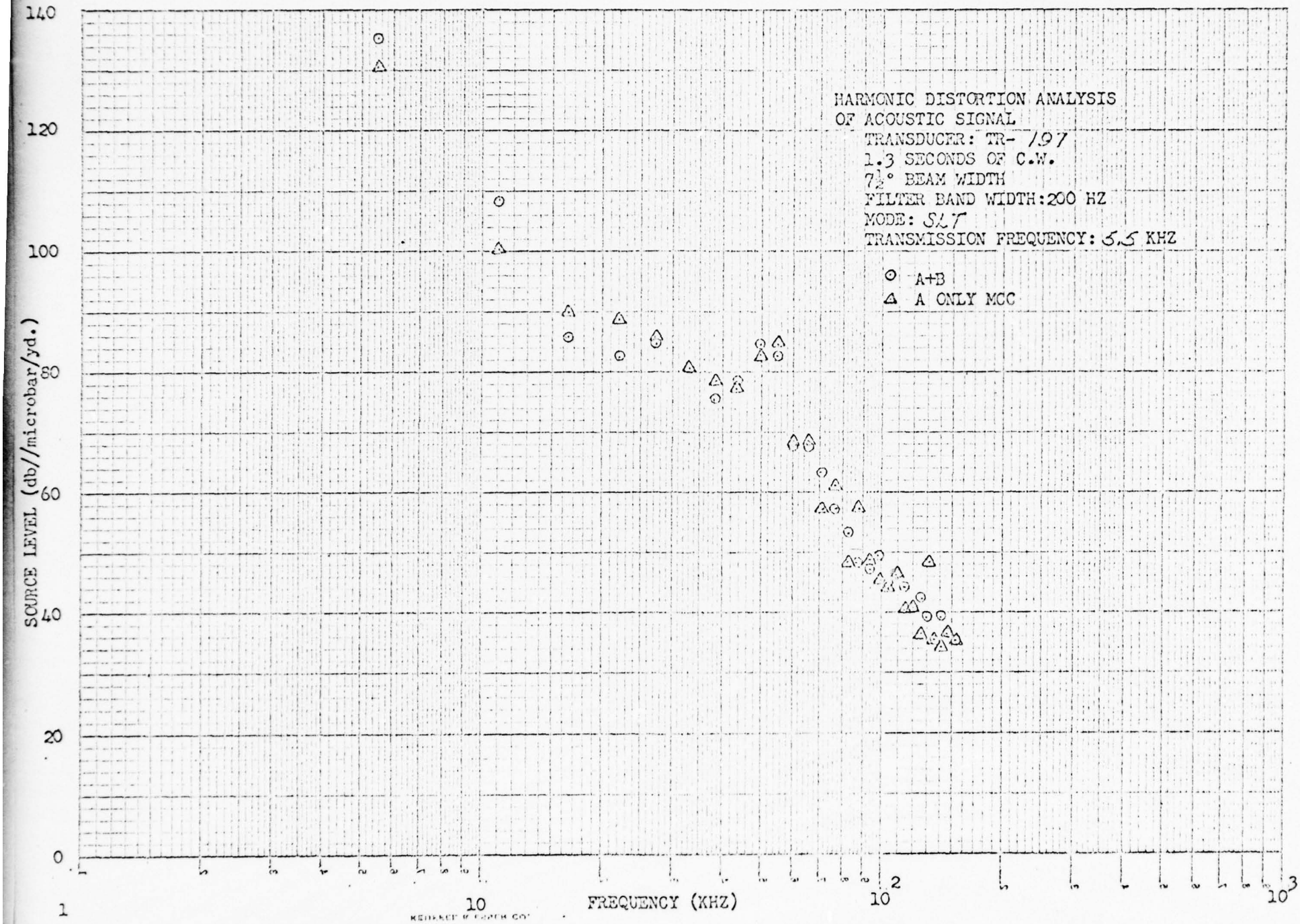
HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR- 197
1.3 SECONDS OF C.W.
7½° BEAM WIDTH
FILTER BAND WIDTH: 200 HZ
MODE: SLT
TRANSMISSION FREQUENCY: 5.5 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
140
120
100
80
60
40
20
0
1
10
10 2
10 3
FREQUENCY (KHZ)

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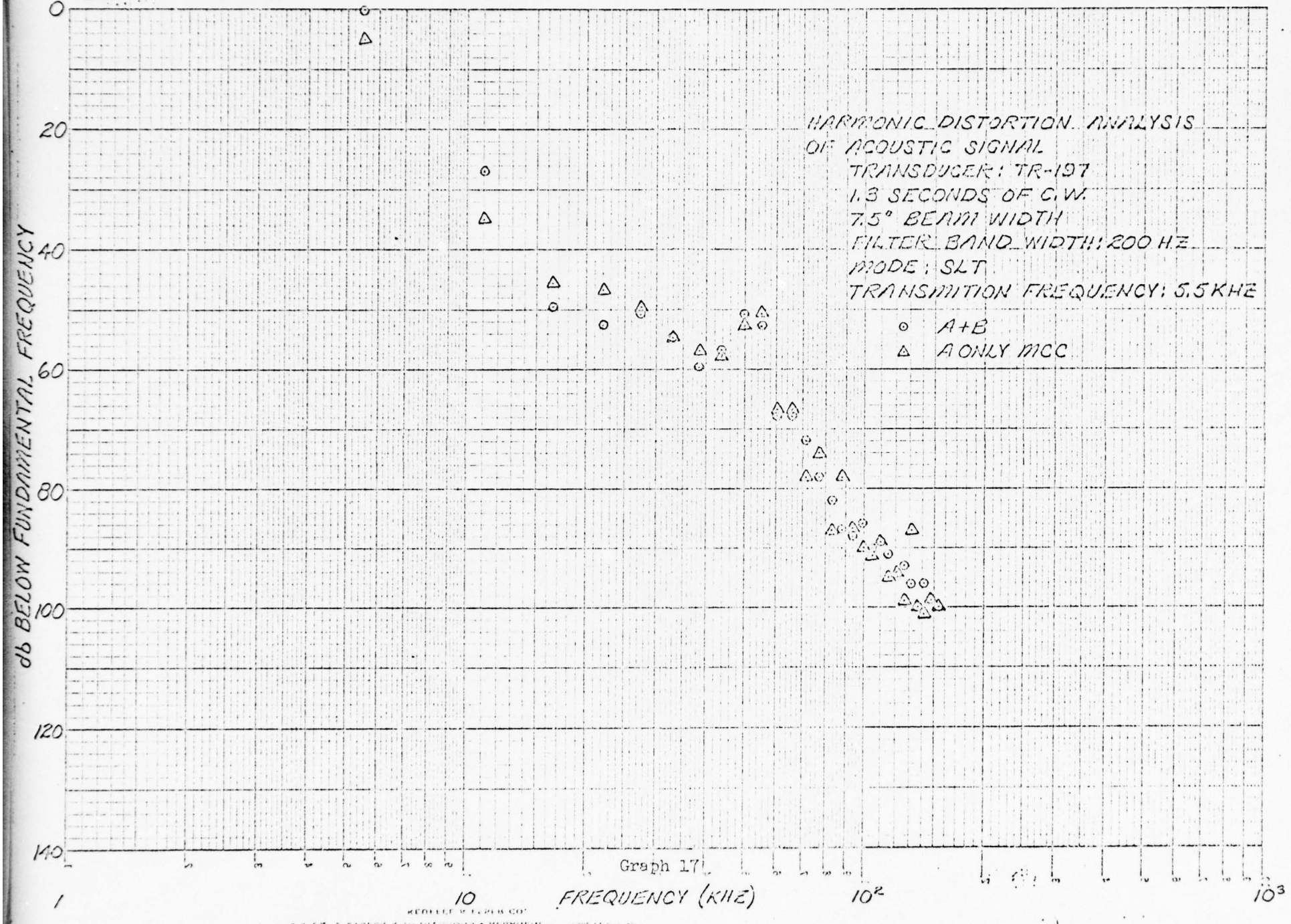


Graph 17



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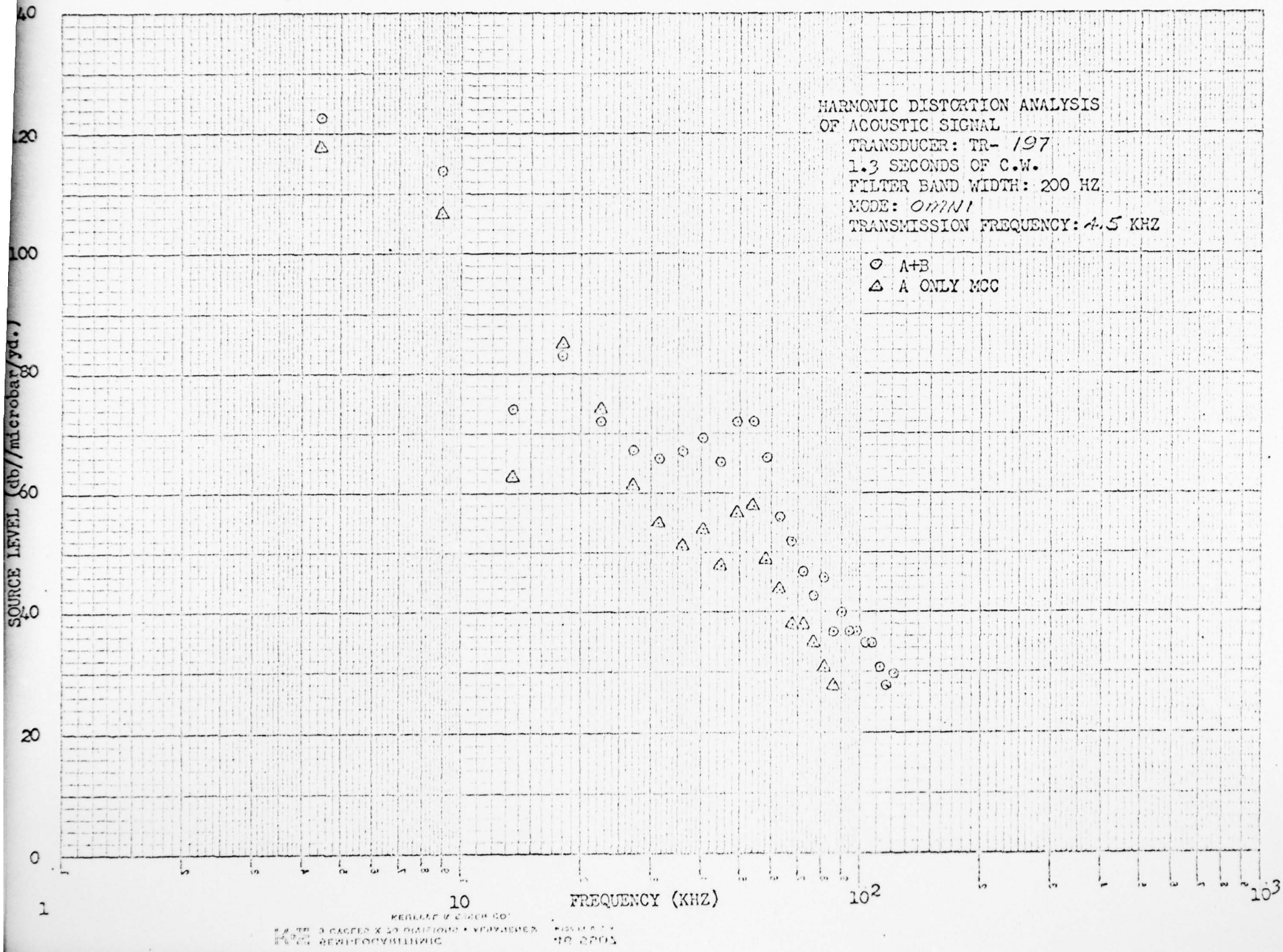
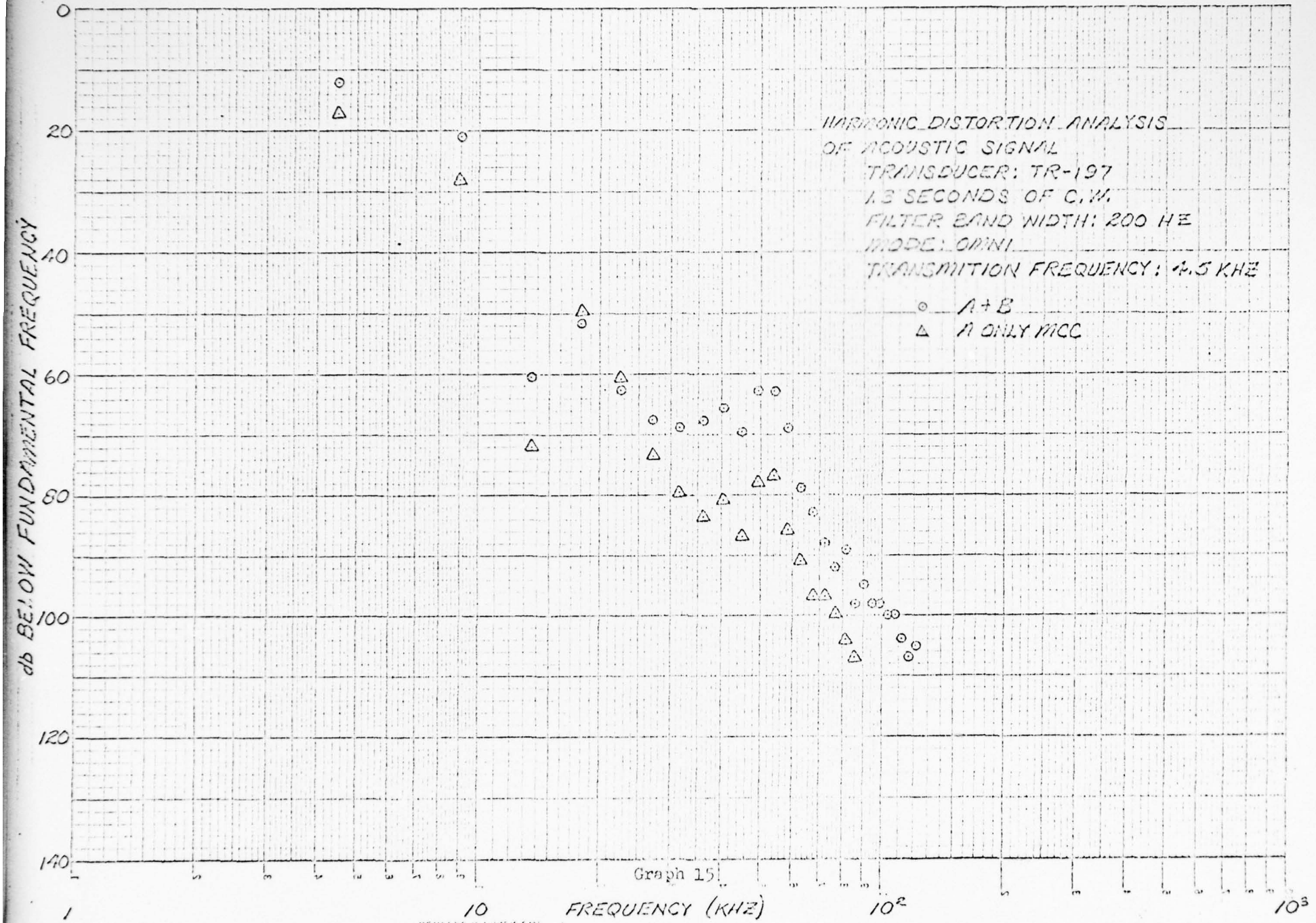
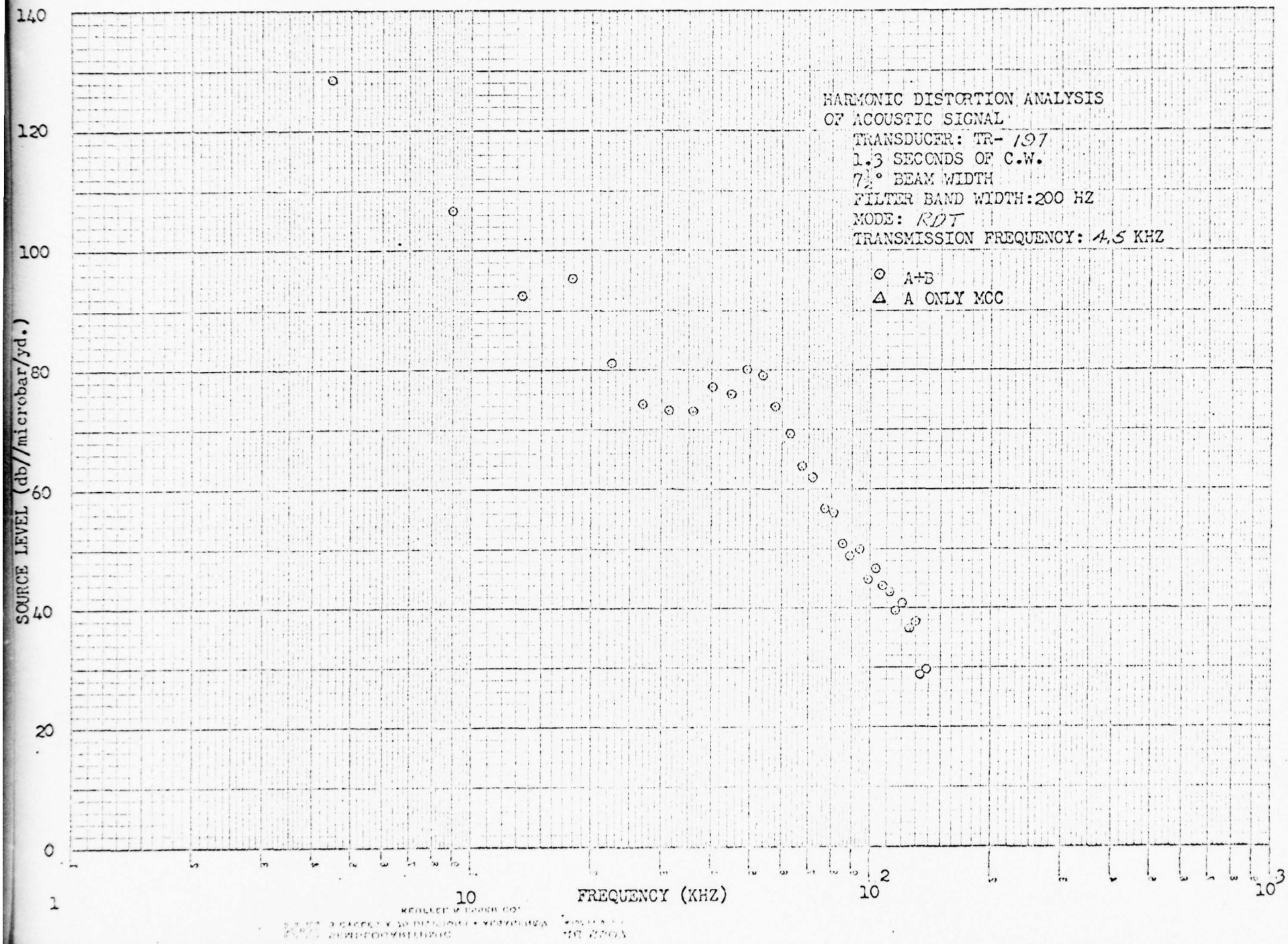

HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR- 197
1.3 SECONDS OF C.W.
FILTER BAND WIDTH: 200 HZ
MODE: OMNI
TRANSMISSION FREQUENCY: 4.5 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
FREQUENCY (KHZ)
40
20
100
80
60
40
20
0
1
10
$10^2$
$10^3$




Graph 15


HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR- 197
1.3 SECONDS OF C.W.
7½° BEAM WIDTH
FILTER BAND WIDTH:200 HZ
MODE: RDT
TRANSMISSION FREQUENCY: 4.5 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
140
120
100
80
60
40
20
0
1
10
FREQUENCY (KHZ)
10 2
10 3

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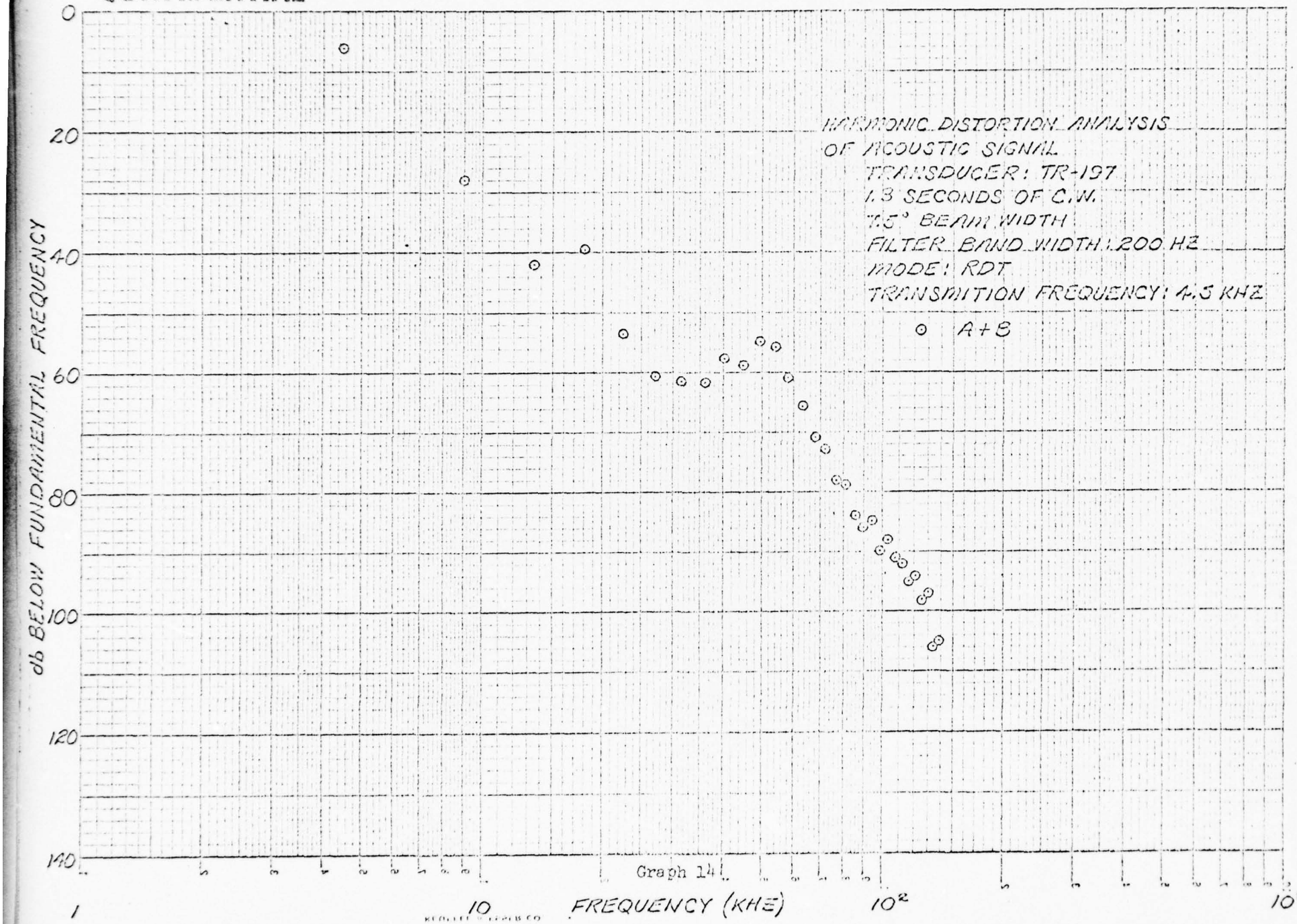


Graph 14

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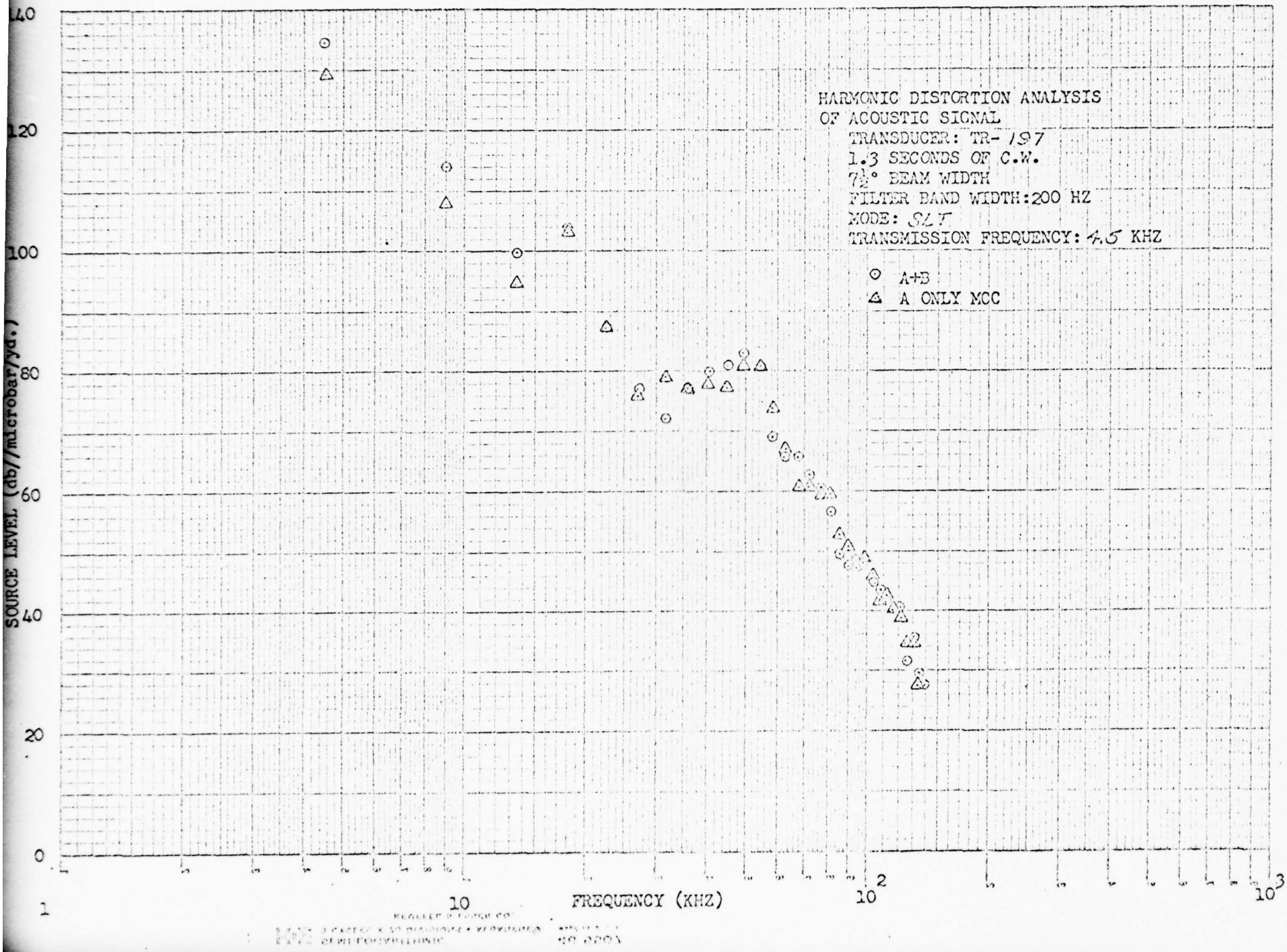
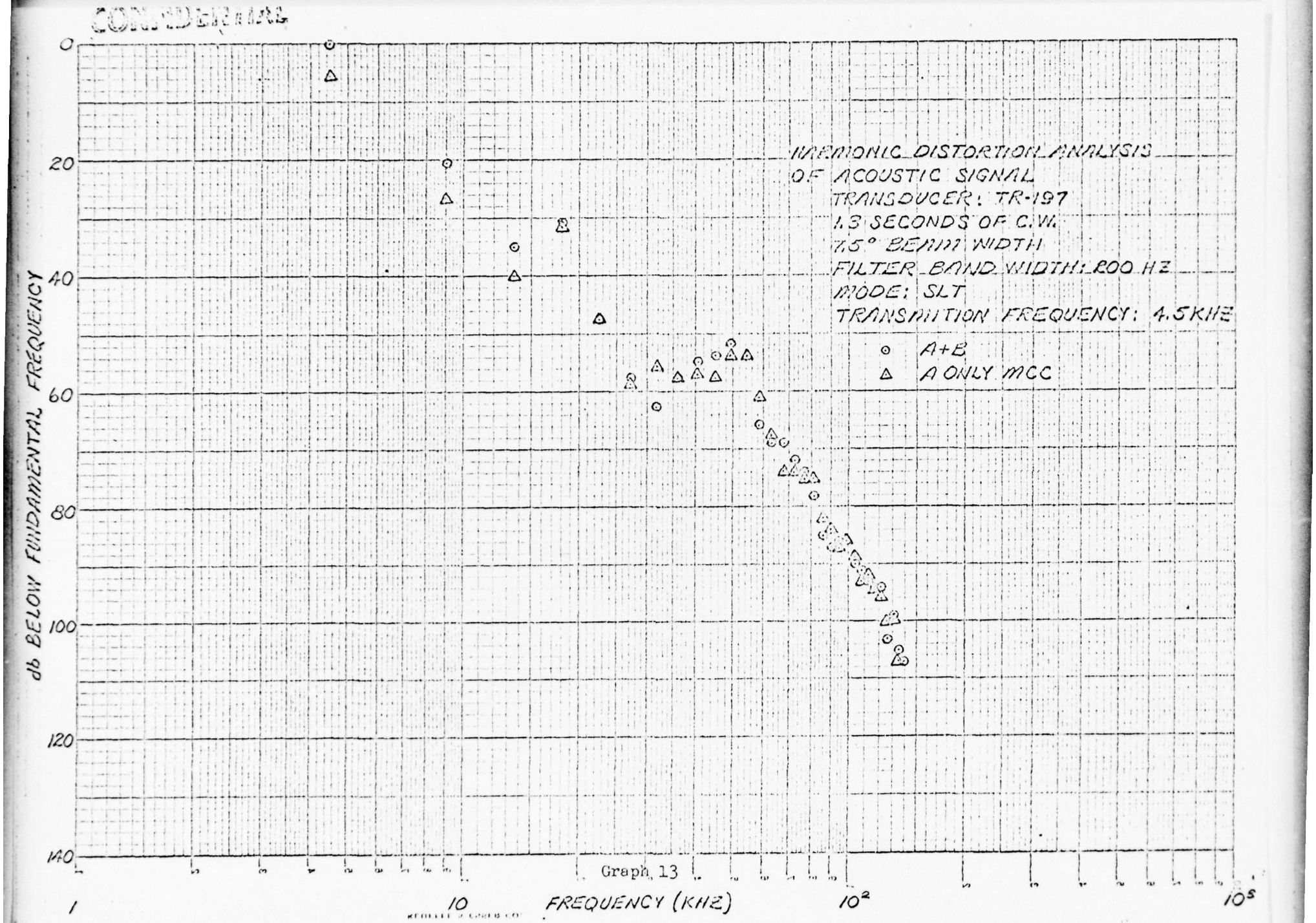

HARMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR- 197
1.3 SECONDS OF C.W.
7½° BEAM WIDTH
FILTER BAND WIDTH:200 HZ
MODE: SLT
TRANSMISSION FREQUENCY: 45 KHZ
A+B
A ONLY MCC
SOURCE LEVEL (db//microbar/yd.)
140
120
100
80
60
40
20
0
1
10
10 2
10 3
FREQUENCY (KHZ)


MNEMONIC DISTORTION ANALYSIS
OF ACOUSTIC SIGNAL
TRANSDUCER: TR-197
1.3 SECONDS OF C.W.
7.5° BEAM WIDTH
FILTER BAND WIDTH: 200 HZ
MODE: SLT
TRANSMITTION FREQUENCY: 4.5KHZ
A+B
A ONLY MCC
db BELOW FUNDAMENTAL FREQUENCY
0
20
40
60
80
100
120
140
1
10
FREQUENCY (KHZ)
10²
10³

Graph 13

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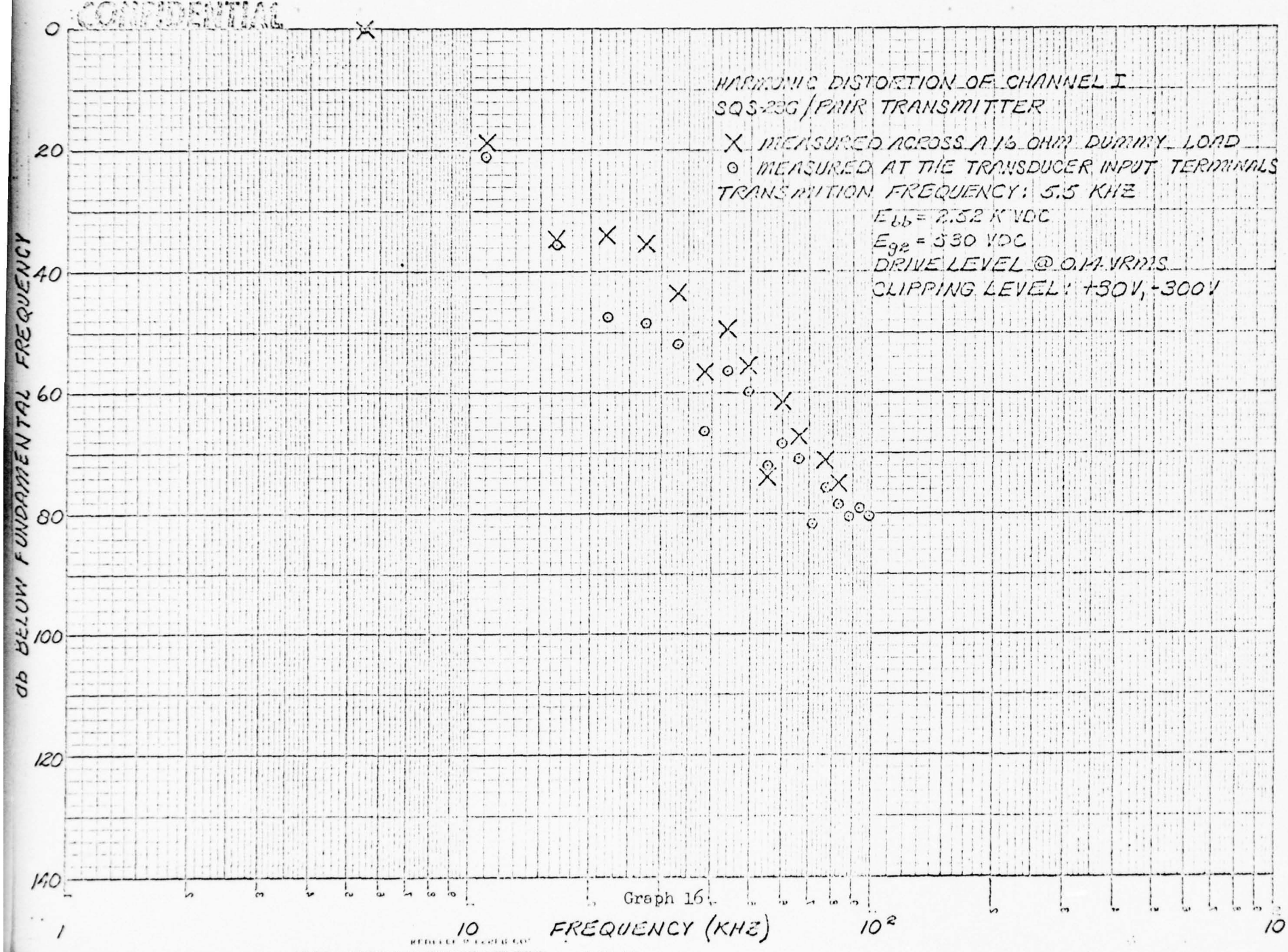


Graph 16

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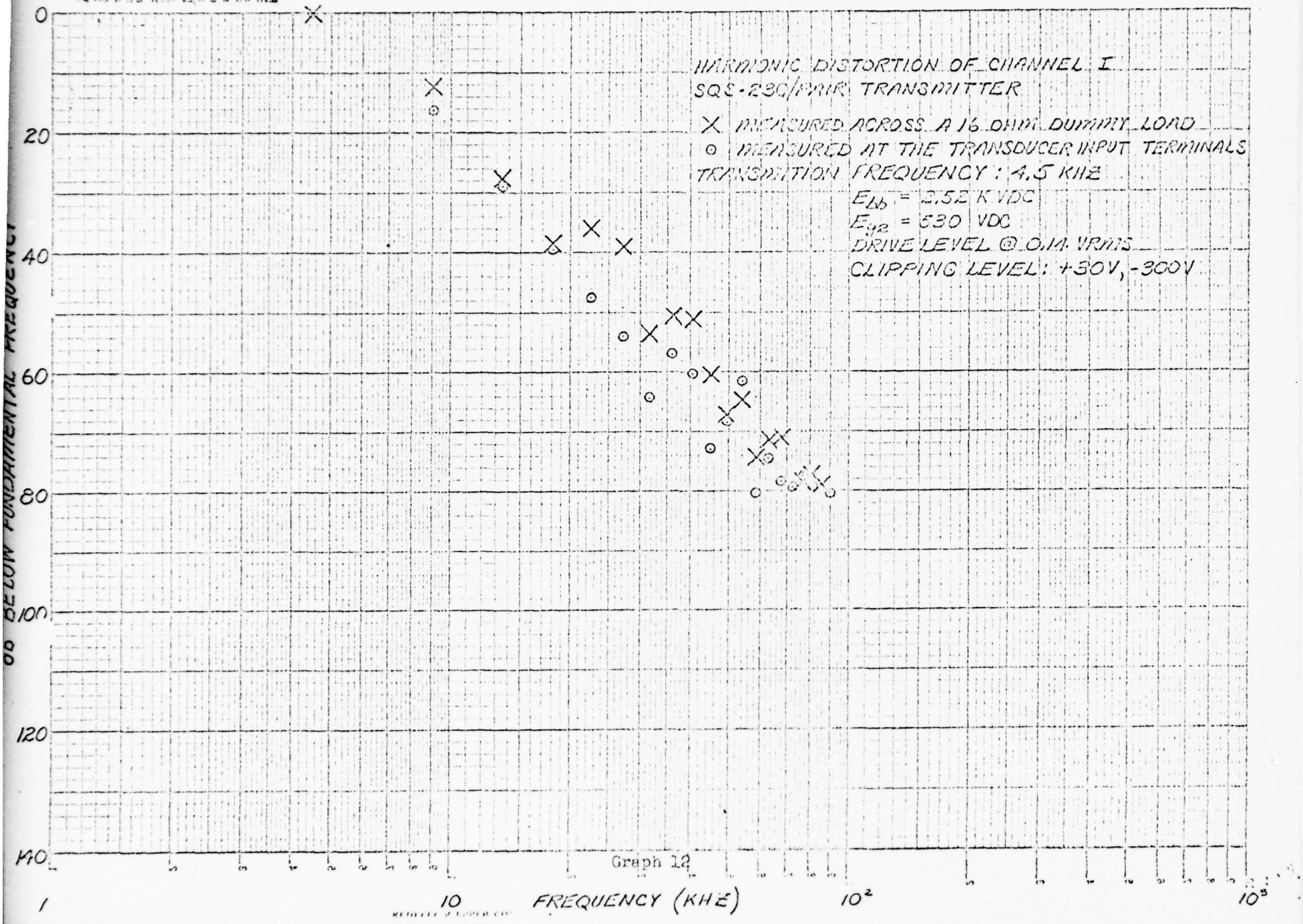


Graph 12

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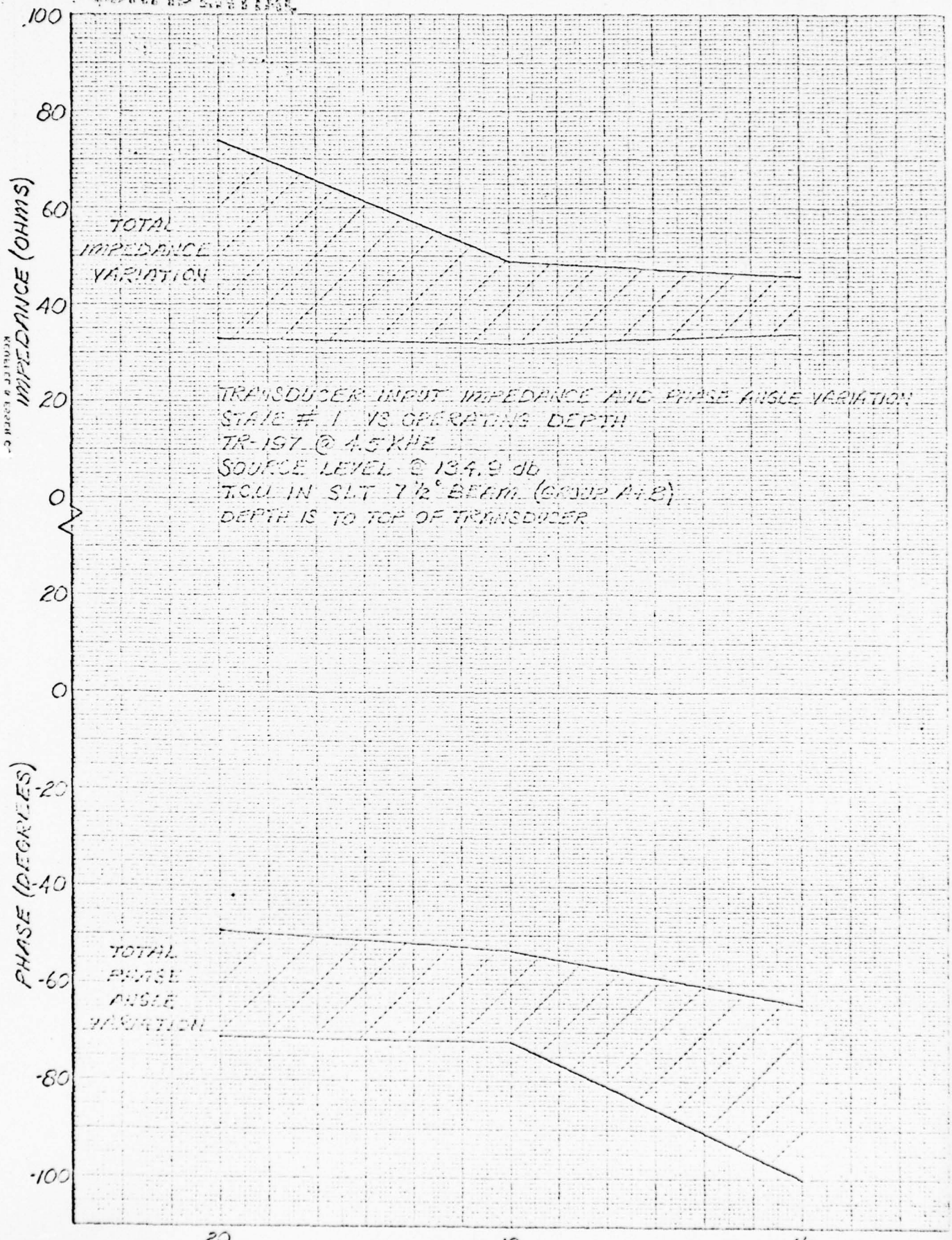
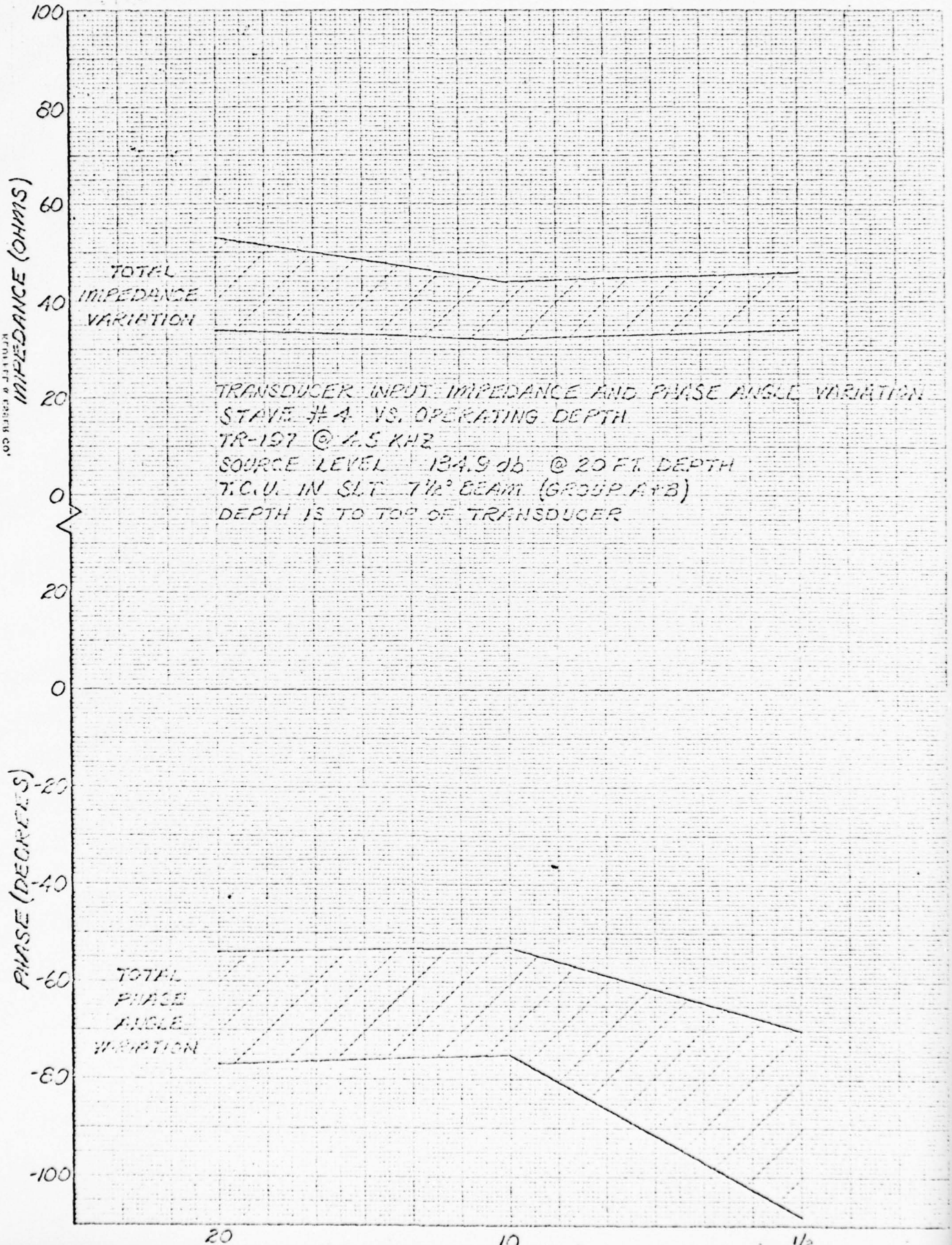
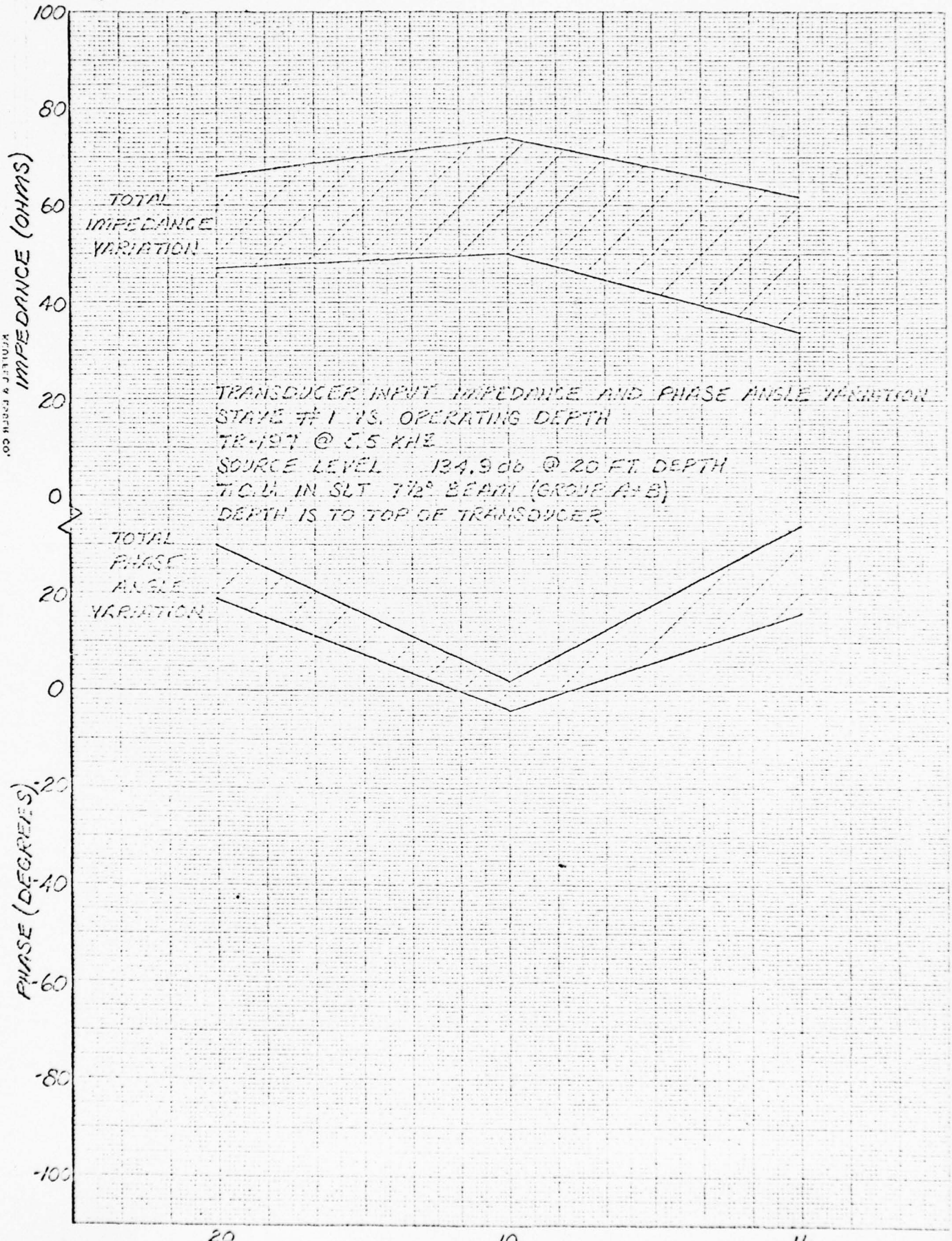



Graph 20


100
80
60
40
20
0
20
0
-20
-40
-60
-80
-100
IMPEDANCE (OHMS)
PHASE (DEGREES)
TOTAL IMPEDANCE VARIATION
TOTAL PHASE ANGLE VARIATION
TRANSDUCER INPUT IMPEDANCE AND PHASE ANGLE VARIATION
STAVE #4 VS. OPERATING DEPTH
TR-197 @ 4.5 KHZ
SOURCE LEVEL 134.9 db @ 20 FT. DEPTH
T.C.U. IN SLT 7½° BEAM (GROUP A+B)
DEPTH IS TO TOP OF TRANSDUCER
20
10
½
DEPTH (FEET)

Graph 21




Graph 22

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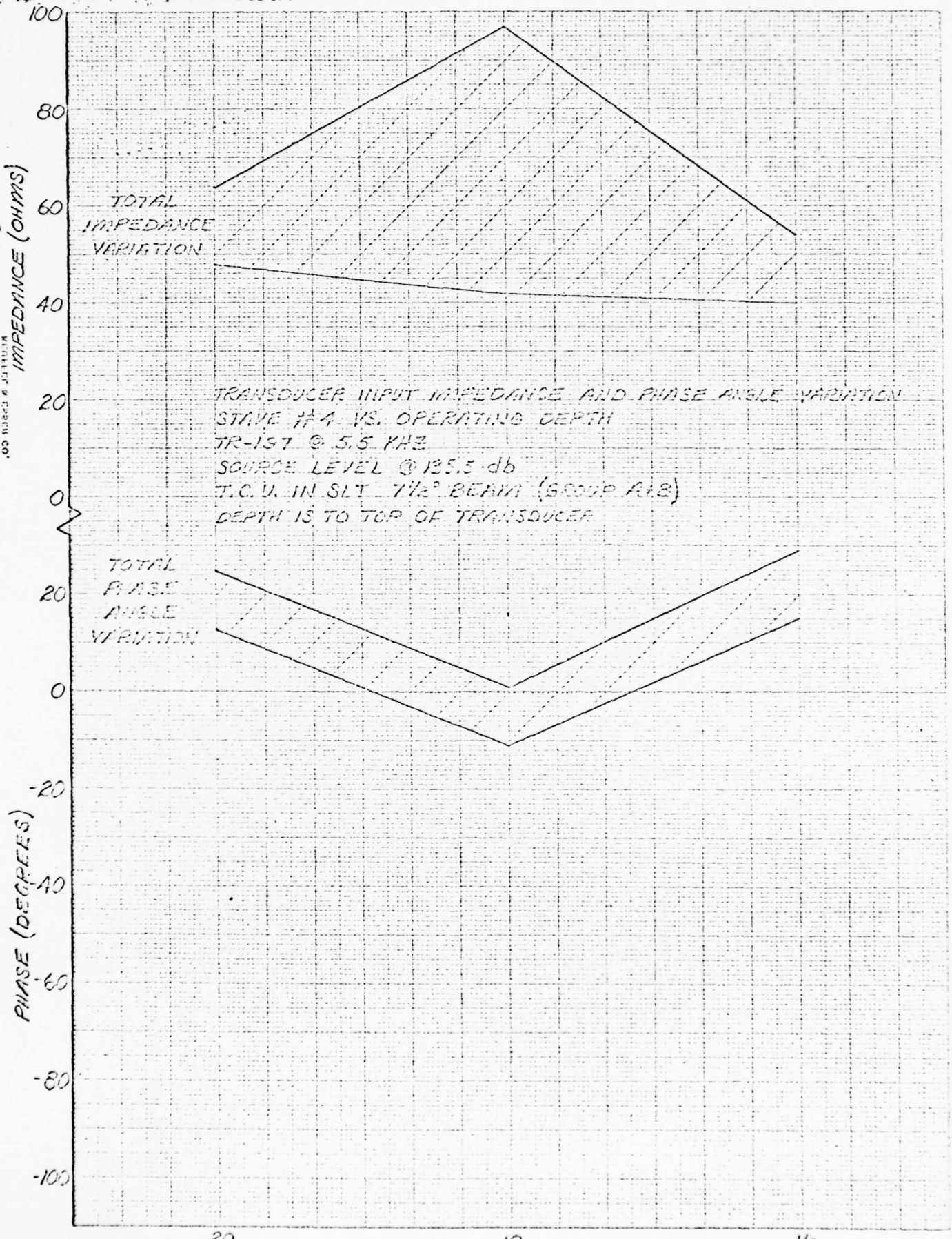


Graph 23

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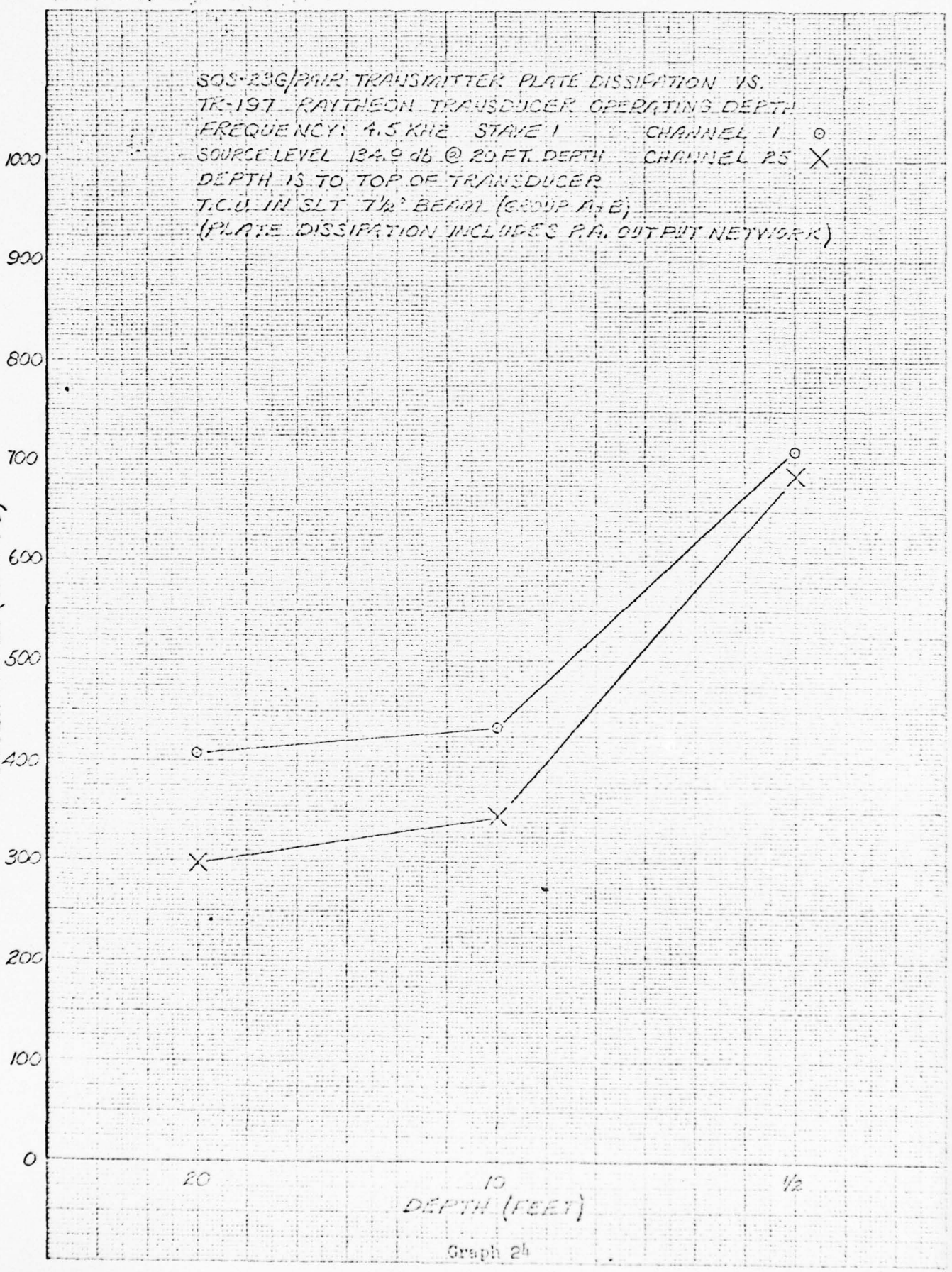
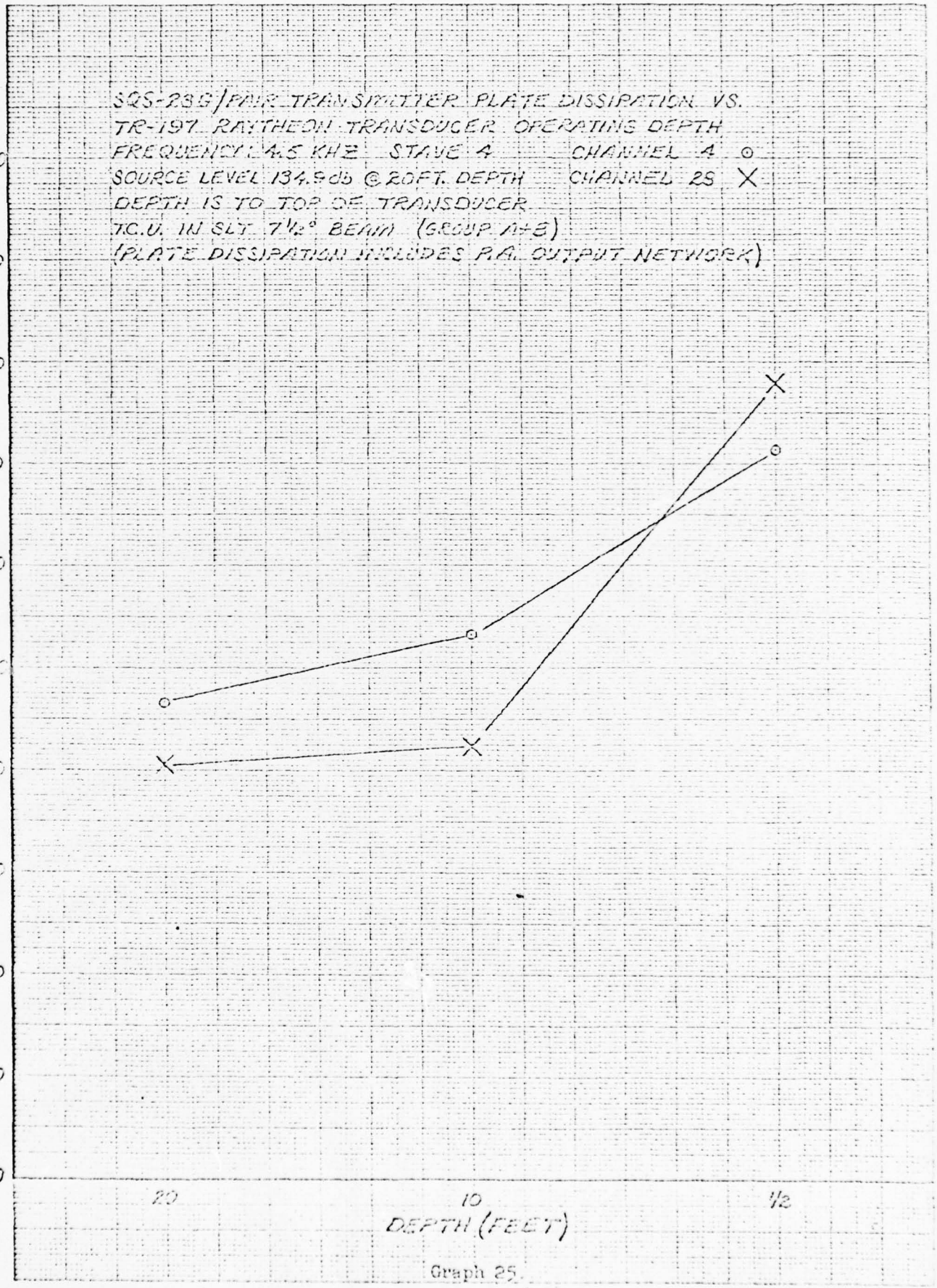
SOS-23G/PAIR TRANSMITTER PLATE DISSIPATION VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 4.5 KHZ STAVE 1 CHANNEL 1 ⊙
SOURCE LEVEL 134.9 db @ 20 FT. DEPTH CHANNEL 25 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT 7½° BEAM (GROUP A, B)
(PLATE DISSIPATION INCLUDES R.A. OUTPUT NETWORK)

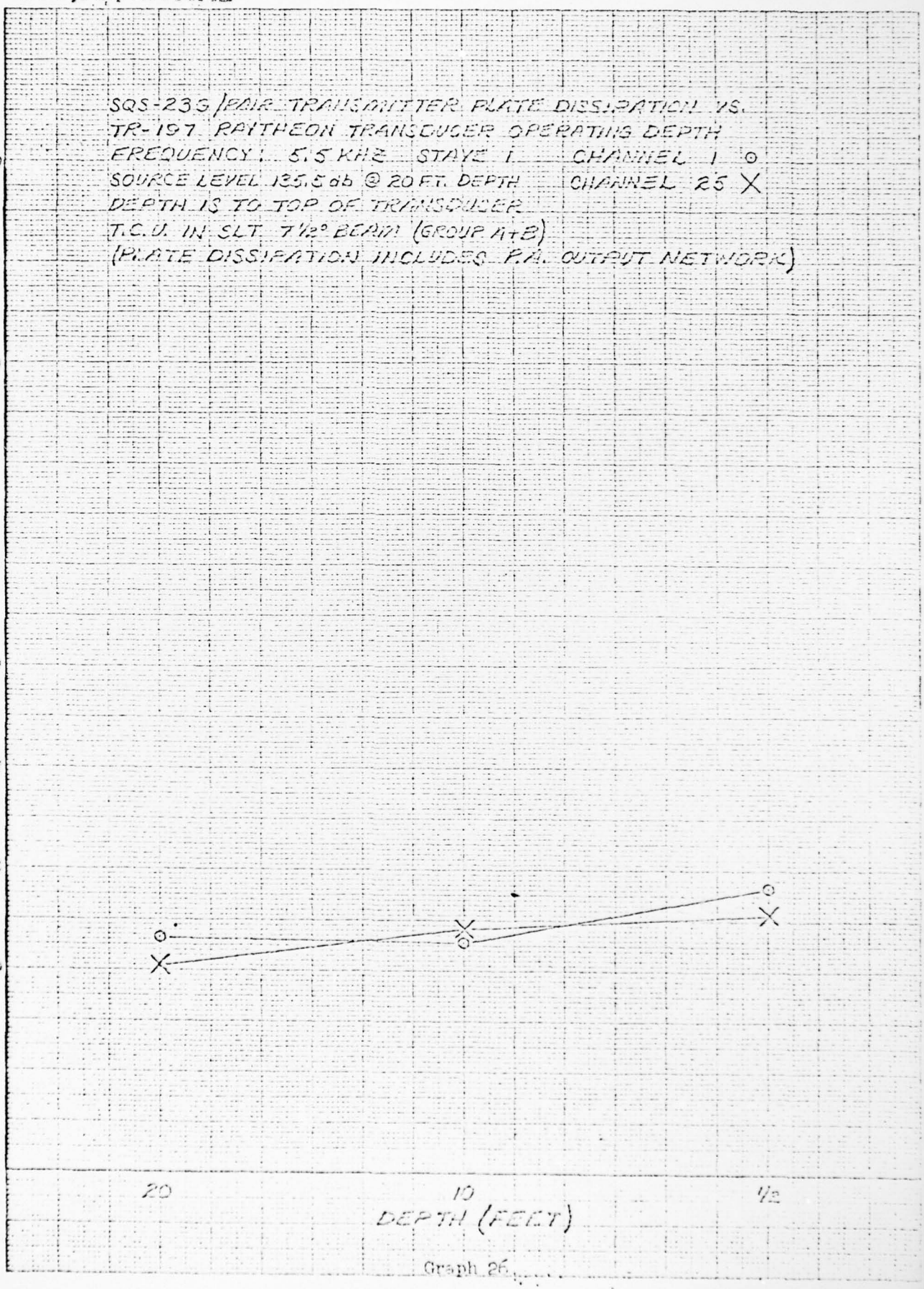



Graph 24



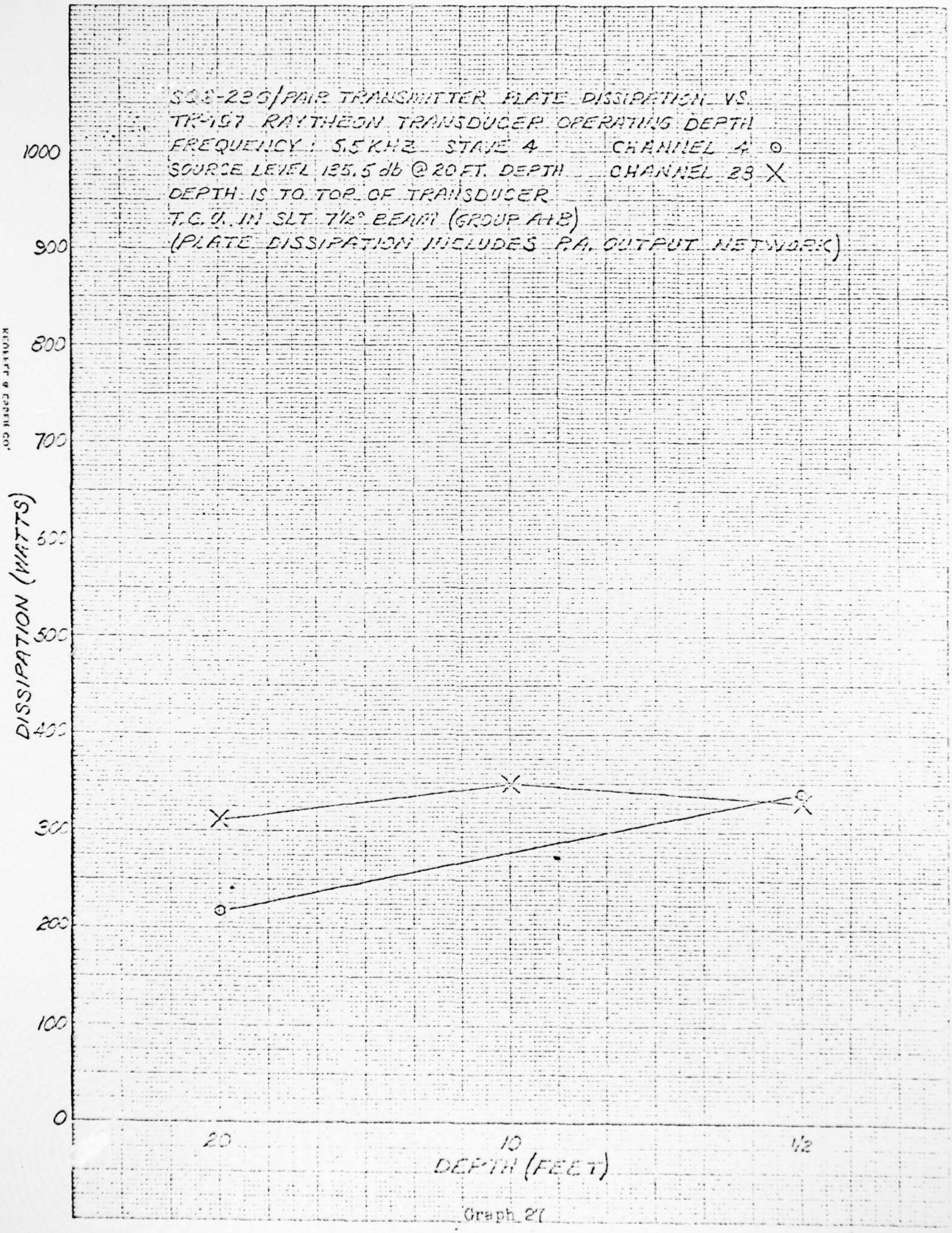

Graph 25

SQS-23G/PAIR TRANSMITTER PLATE DISSIPATION VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 5.5 KHZ STAVE 1 CHANNEL 1 ⊙
SOURCE LEVEL 135.5 db @ 20 FT. DEPTH CHANNEL 25 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. IN SLT 7½° BEAM (GROUP A+B)
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)



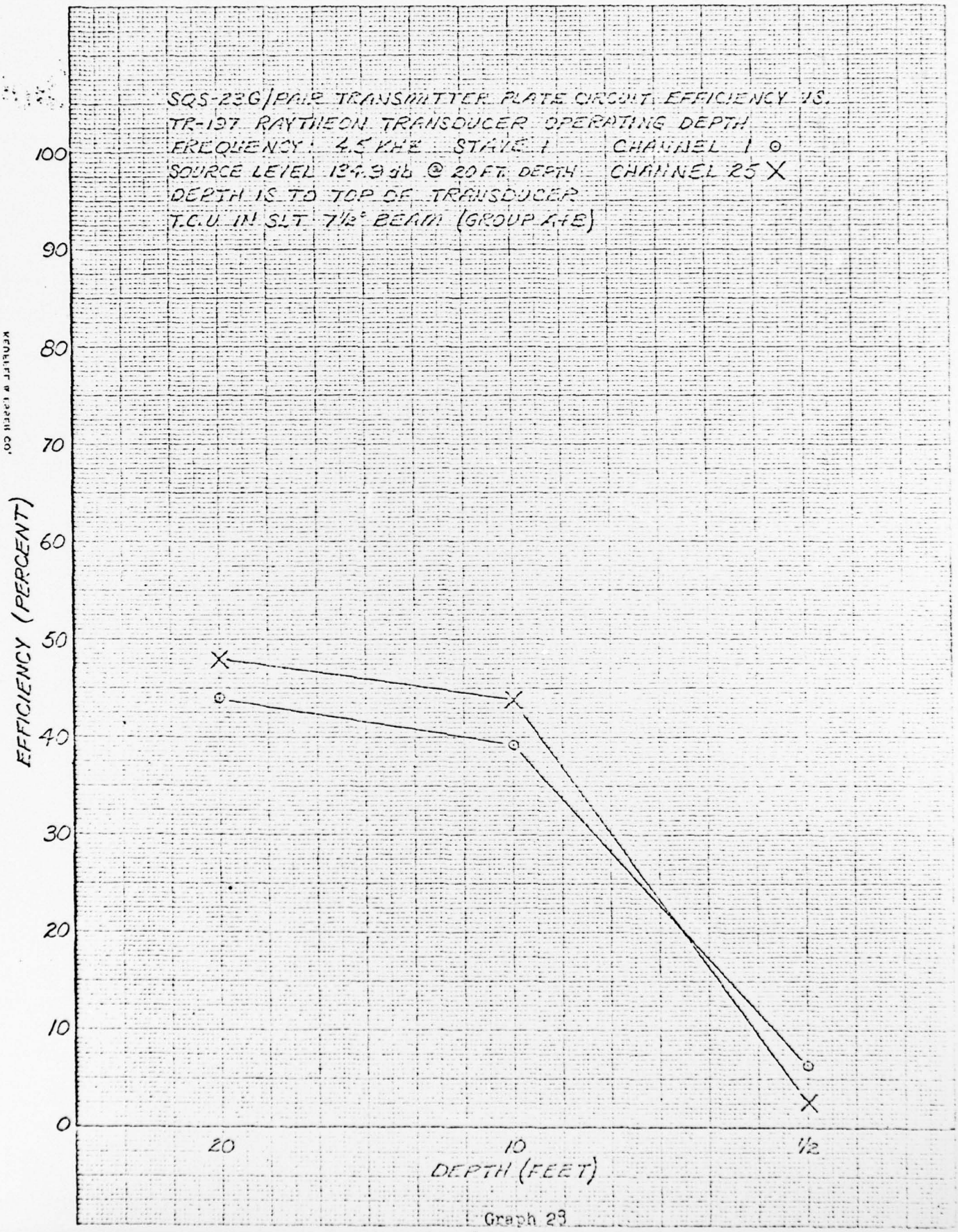

Graph 26

SQS-23G/PAIR TRANSMITTER PLATE DISSIPATION VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 5.5 KHZ STAVE 4 CHANNEL 4 ⊙
SOURCE LEVEL 185.5 db @ 20 FT. DEPTH CHANNEL 28 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.Q. IN SLT 7½° BEAM (GROUP A+B)
(PLATE DISSIPATION INCLUDES P.A. OUTPUT NETWORK)

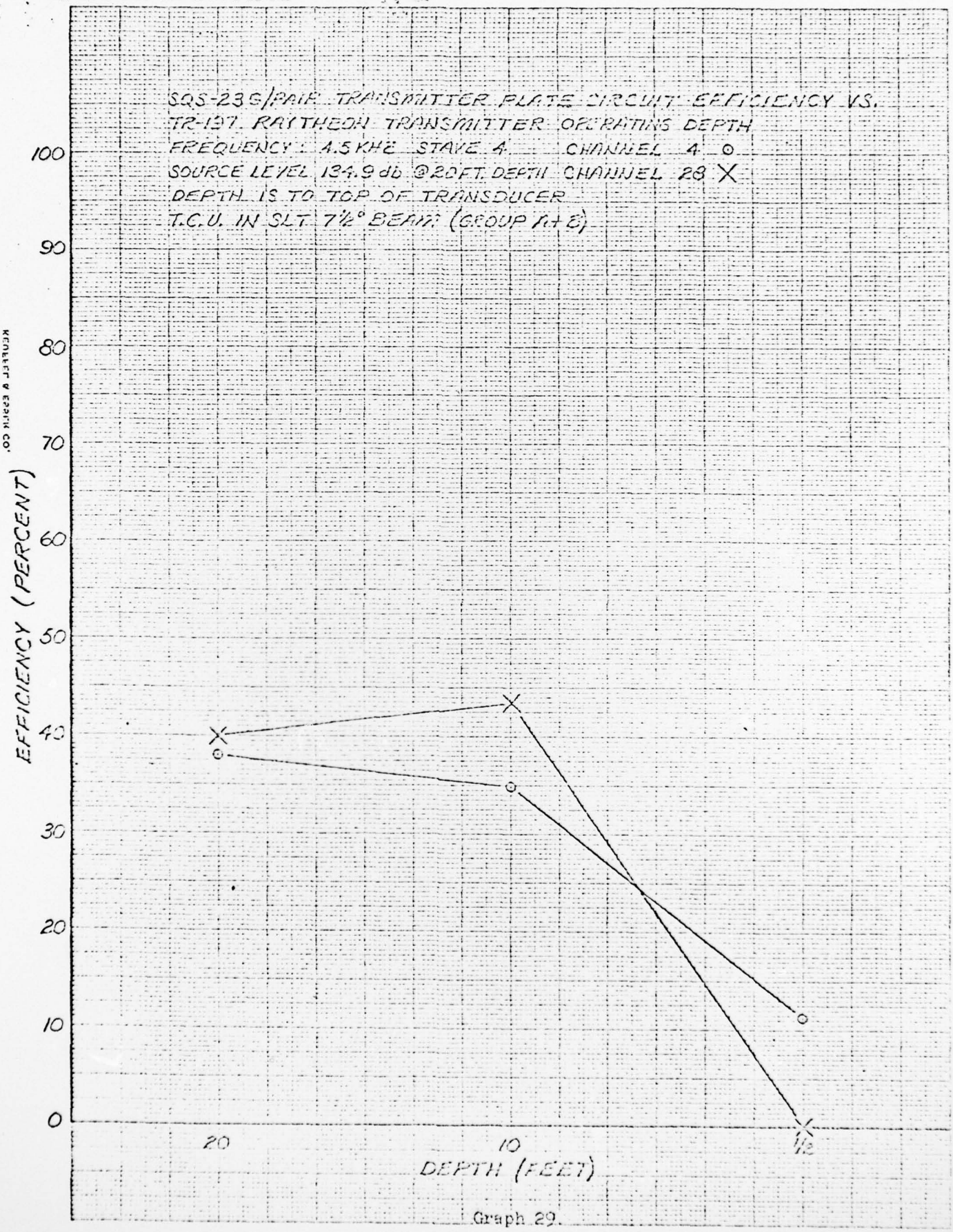



Graph 27

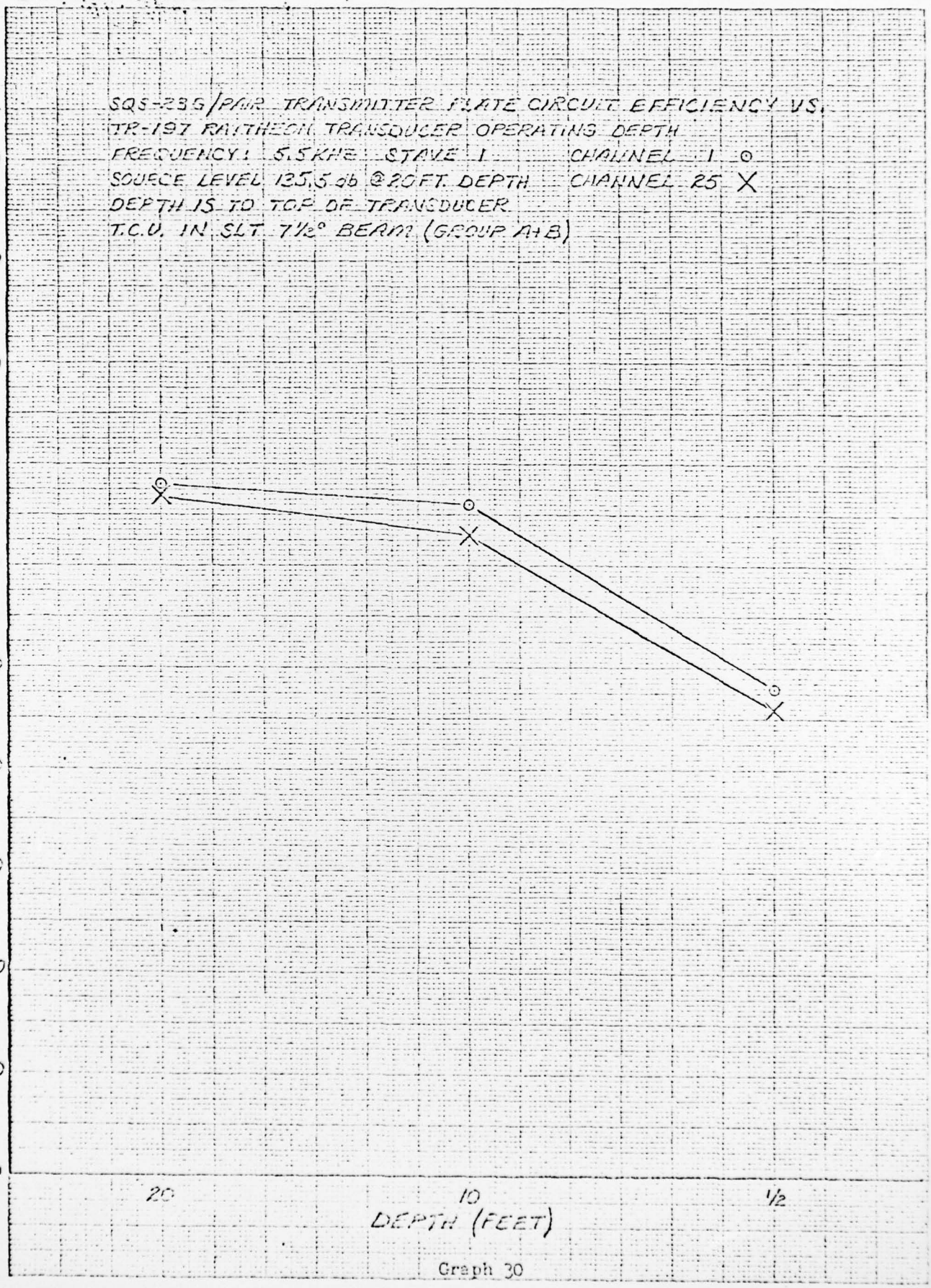
SQS-23G/PAIR TRANSMITTER PLATE CIRCUIT EFFICIENCY VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 4.5 KHZ STAVE 1 CHANNEL 1 ⊙
SOURCE LEVEL 134.9 db @ 20 FT. DEPTH CHANNEL 25 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U IN SLT 7½° BEAM (GROUP A+B)




Graph 23

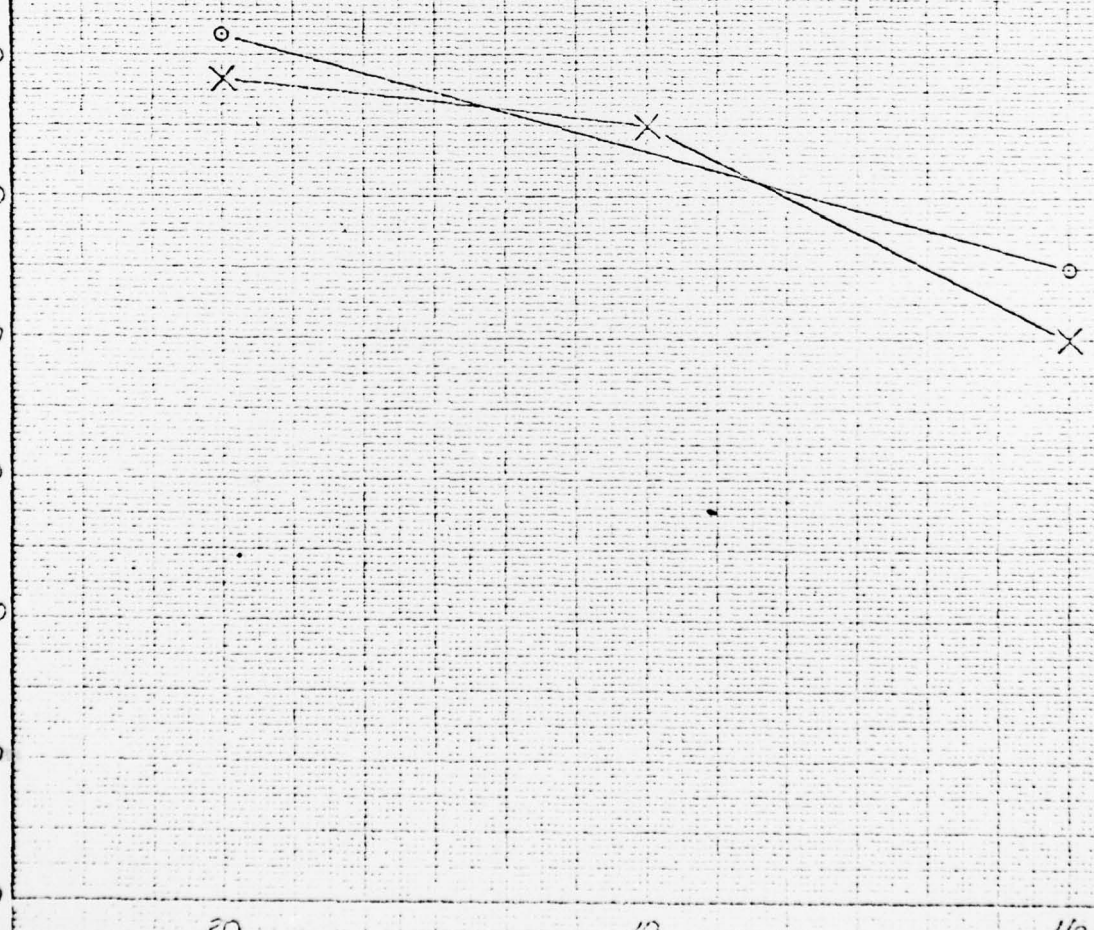



Graph 29.




Graph 30

SQS-23 G/PAIR TRANSMITTER PLATE CIRCUIT EFFICIENCY VS.
TR-197 RAYTHEON TRANSDUCER OPERATING DEPTH
FREQUENCY: 6.5 KHz STAVE 4 CHANNEL 4 ⊙
SOURCE LEVEL 135.5 db @ 20 FT. DEPTH CHANNEL 28 X
DEPTH IS TO TOP OF TRANSDUCER
T.C.U. III SLT 7½° BEAM (GROUP A+B)




Graph 31

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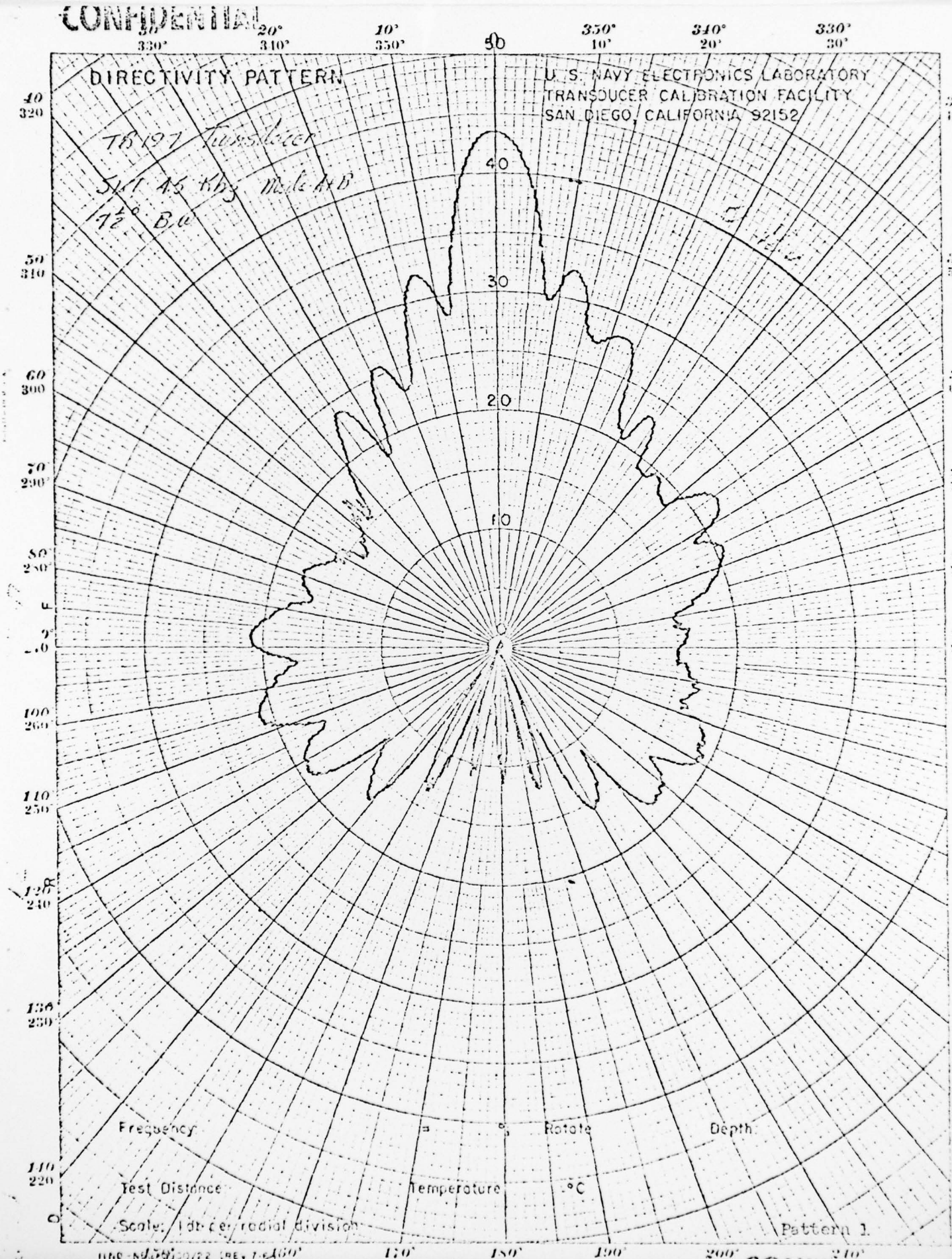
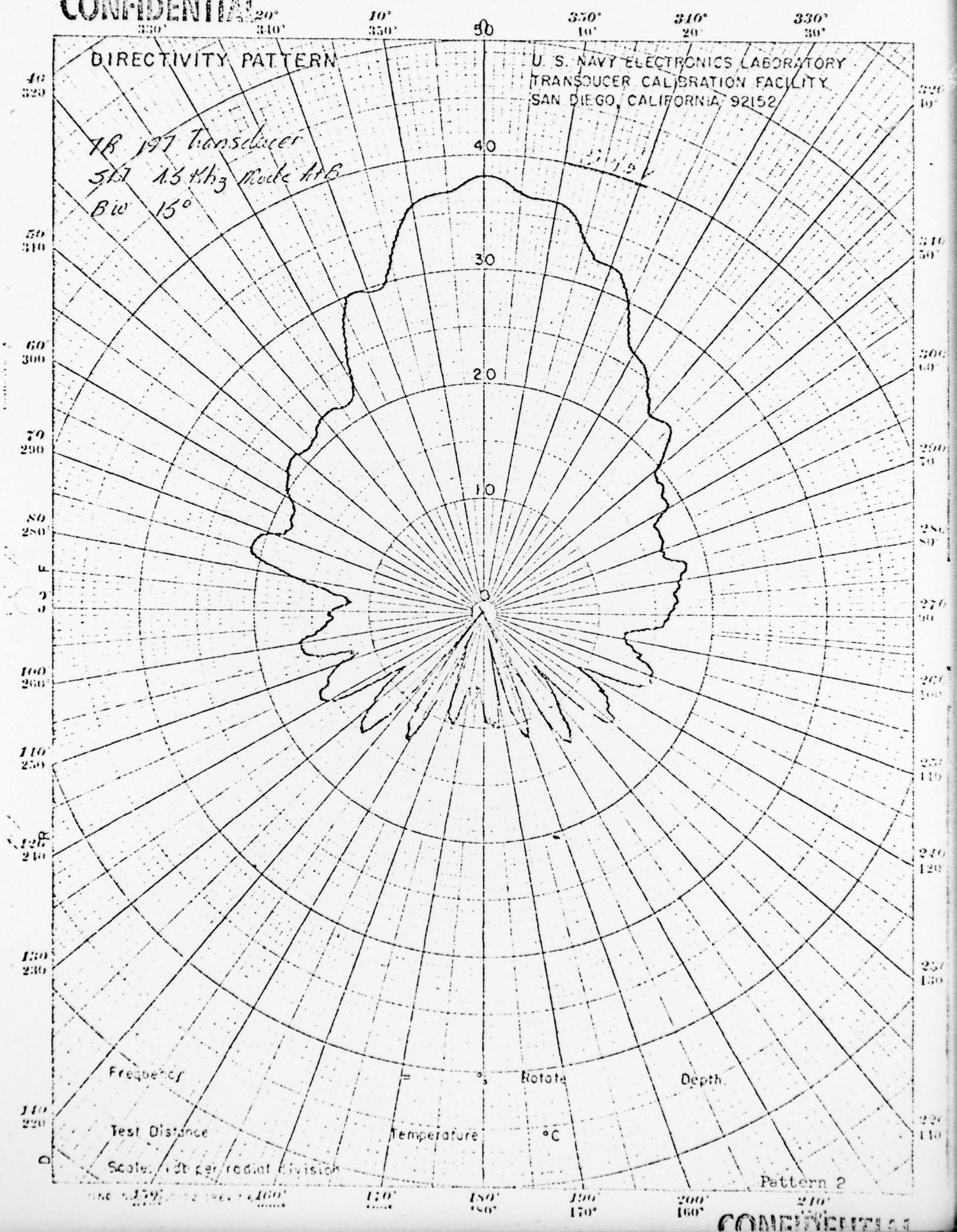



CONFIDENTIAL

CONFIDENTIAL

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