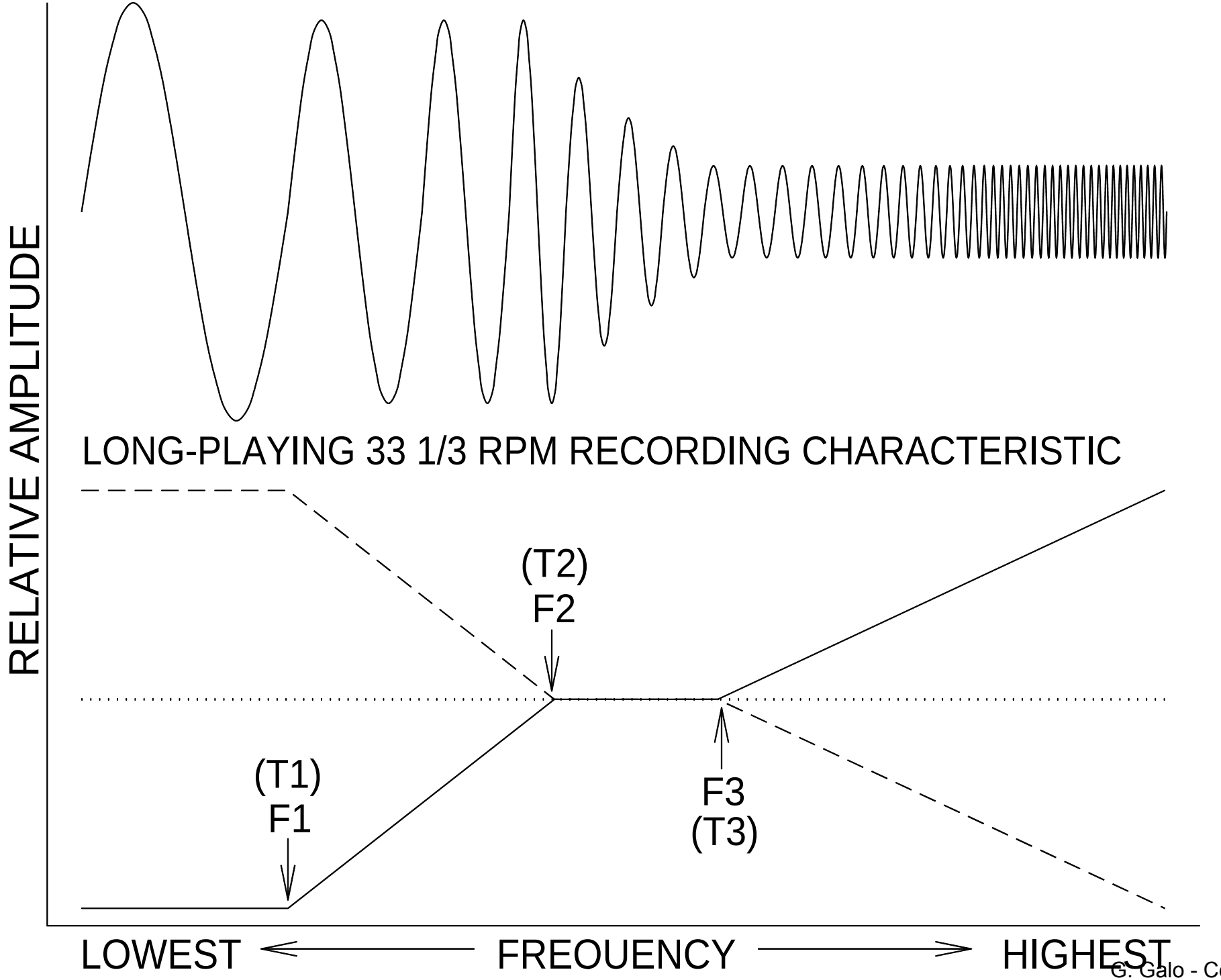

# THE COLUMBIA Lp EQUALIZATION CURVE

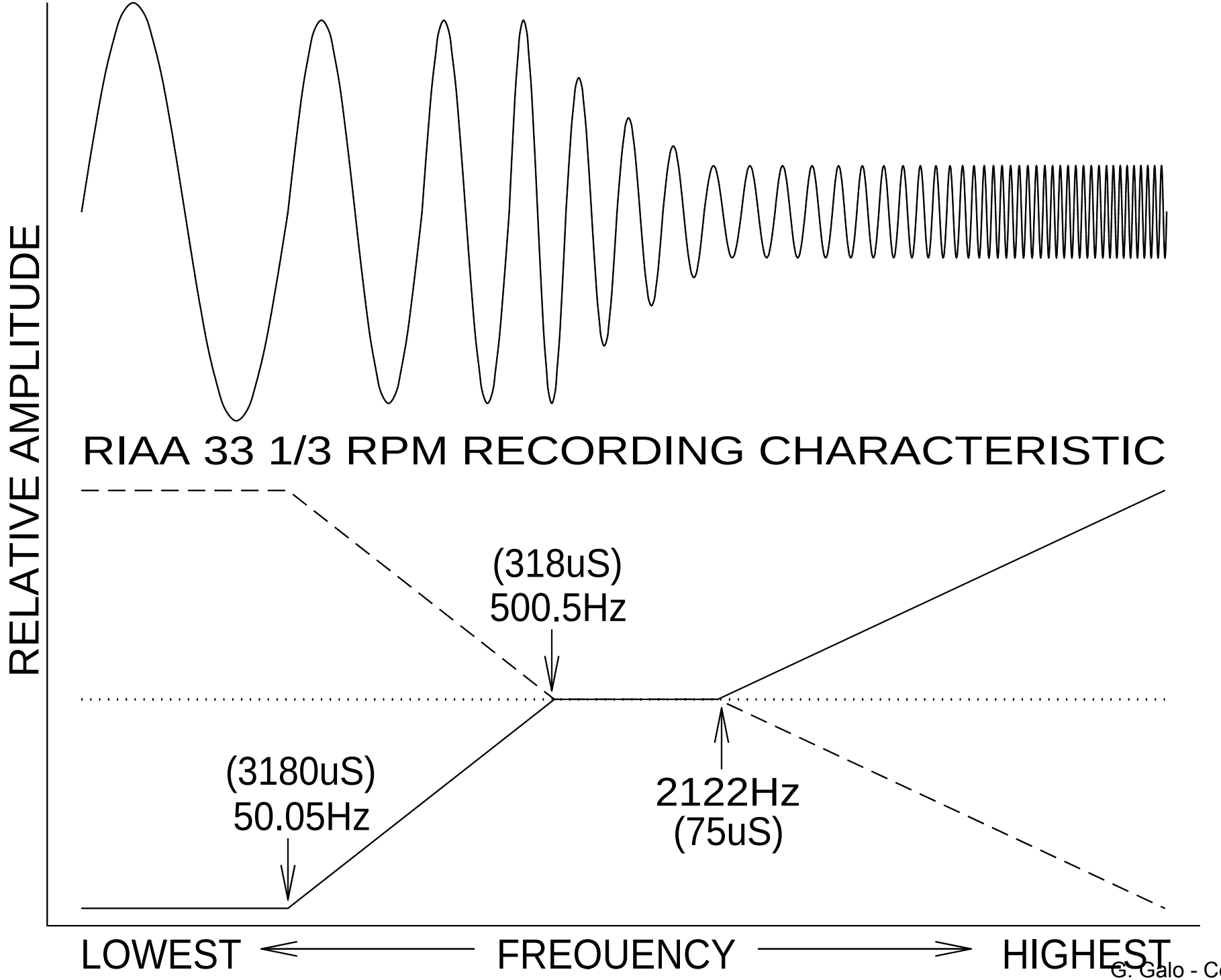
Presented by

Gary A. Galo

ARSC Conference

March 29, 2008


RELATIVE AMPLITUDE
LONG-PLAYING 33 1/3 RPM RECORDING CHARACTERISTIC
(T2)
F2
(T1)
F1
F3
(T3)
LOWEST
FREQUENCY
HIGHEST


RELATIVE AMPLITUDE
RIAA 33 1/3 RPM RECORDING CHARACTERISTIC
(318uS)
500.5Hz
(3180uS)
50.05Hz
2122Hz
(75uS)
LOWEST
FREQUENCY
HIGHEST

# The Columbia Lp Equalization Curve: Conflicting Opinions

Note: F = Turnover Frequency and T = Time Constant
$T = 1 / 2\pi F$ and $F = 1 / 2\pi T$

1. KAB Souvenir EQS MK12 Manual:
   F1 = 50Hz (T1 = 3180µS)
   F2 = 500Hz (T2 = 318µS)
   F3 = 1590Hz (T3 = 100 µS or +/- 16dB at 10kHz)

2. Tremaine
   F1 not specified
   F2 = 300Hz
   F3 not specified

3. Copeland:
   T1 = 1590µS (F1 = 100Hz)
   T2 = 400µS (F2 = 398Hz)
   T3 = 100µS (F3 = 1590 Hz or +/- 16dB at 10kHz)

4. Copeland's interpretation of Langford-Smith's Fig. 17.15:
   T1 = 1590µS (F1 = 100Hz)
   T2 = 350µS (F2 = 455Hz)
   T3 = 100µS (F3 = 1590 Hz or +/- 16dB at 10kHz)

5. McIntosh C-8 Equalization Chart (12/20/1956, S.N. 10600 and up):
   F1 not specified
   F2 = 750 Hz (with Bass control set at -2)
   F3 = +/- 16dB at 10kHz (1590Hz; T3 = 100µS)

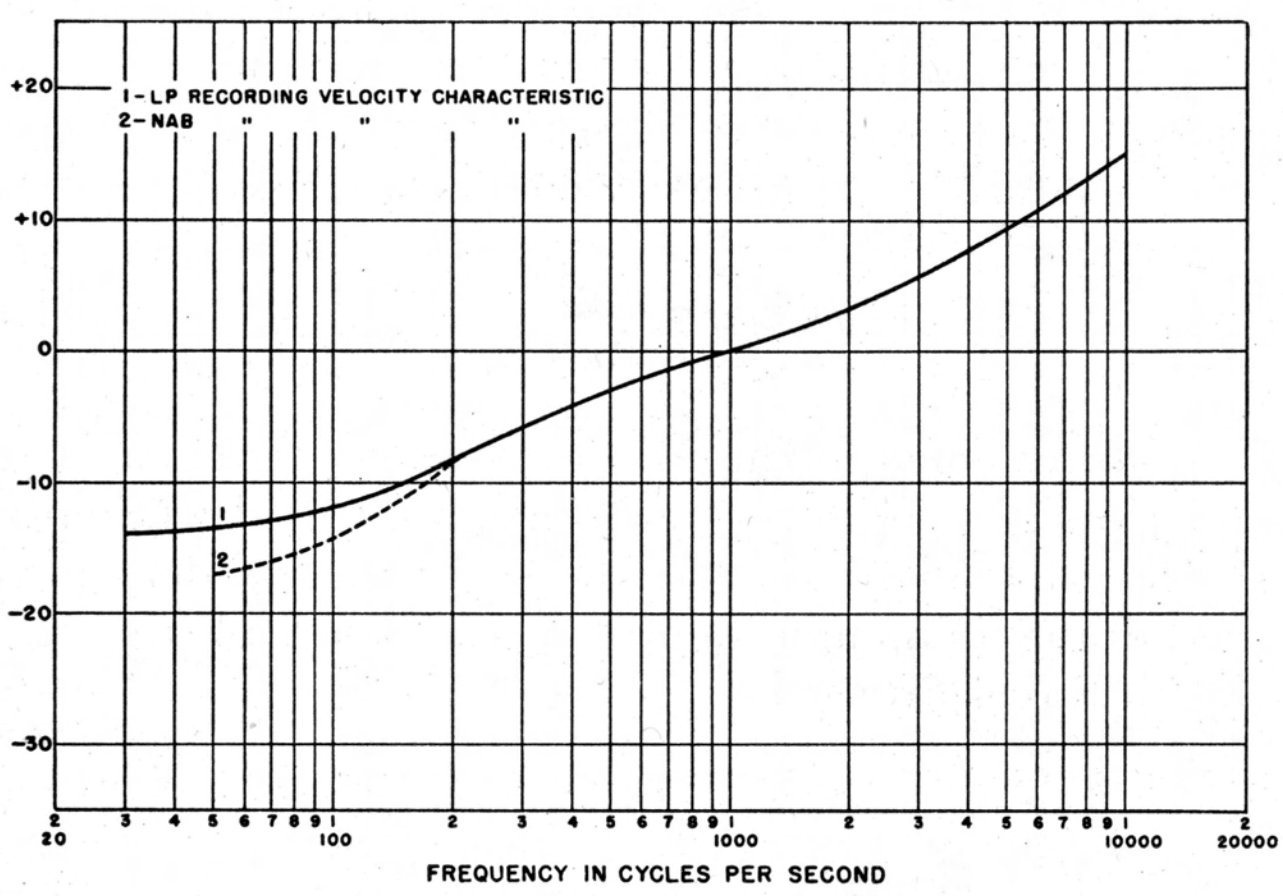
6. Powell, High Fidelity Magazine (Sept. 1955), Rek-O-Kut (Esoteric) Re-Equalizer II Operating Manual, and others:
   F1 not specified
   F2 = 500Hz (modified NAB) (T2 = 318µS)
   F3 = +/- 16dB at 10kHz (NAB) (1590Hz; T3 = 100µS)

7. Eargle and others:
   F1 = 100Hz (T1 = 1590µS)
   F2 = 500Hz (T2 = 318µS)
   F3 = 1590Hs (T3 = 100µS or +/- 16dB at 10kHz)

1949 PROCEEDINGS OF THE I.R.E.—Waves and Electrons Section 923

# The Columbia Long-Playing Microgroove Recording System*

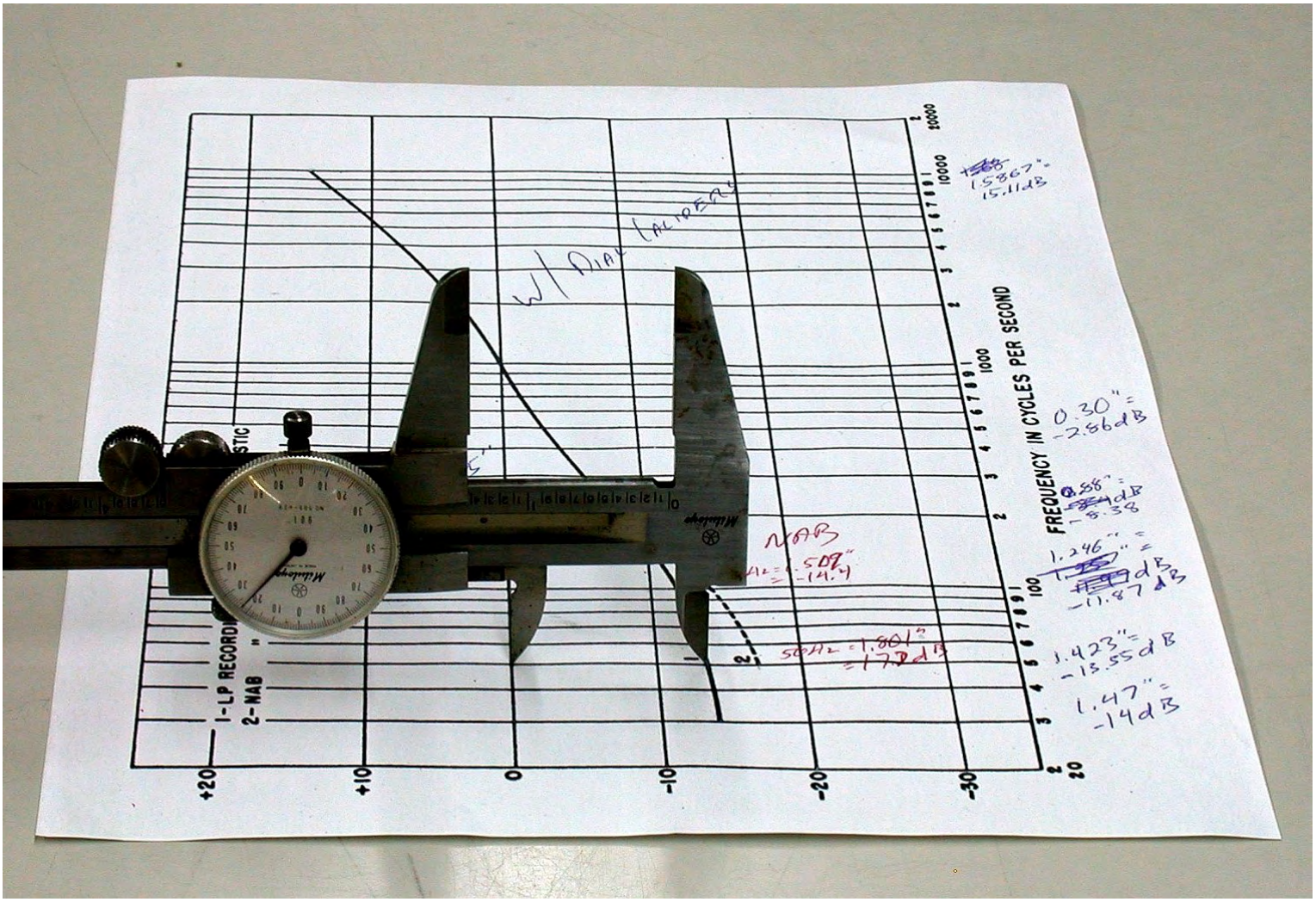
PETER C. GOLDMARK†, FELLOW, IRE, RENÉ SNEPVANGERS†, AND WILLIAM S. BACHMAN‡, MEMBER, IRE



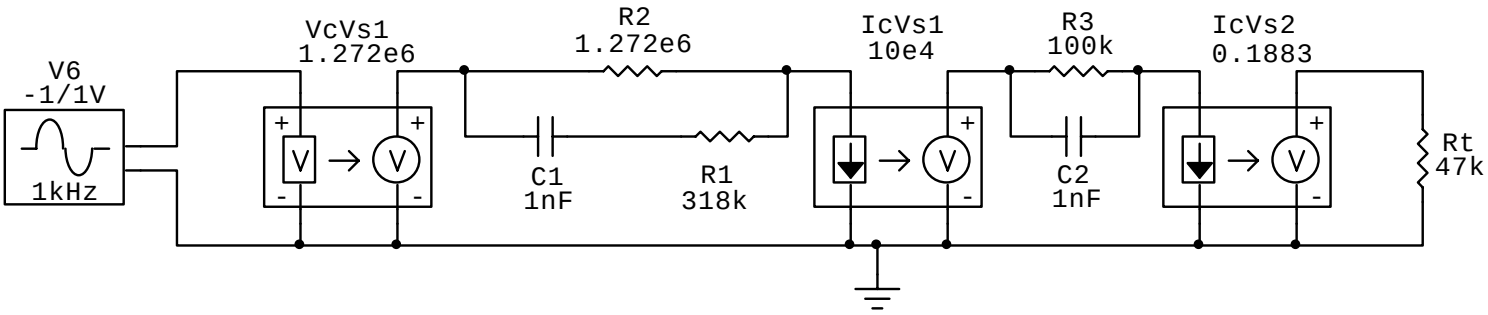

**BELOW 200Hz: TOP CURVE IS COLUMBIA; LOWER CURVE IS NAB**

| | |
|---|---|
| 30Hz | -14.00dB |
| 50Hz | -13.55dB |
| 100Hz | -11.87dB |
| 200Hz | -8.38dB |
| 500Hz | -2.86dB |

# MEASUREMENT OF SNEPVANGERS GRAPH
# USING DIAL CALIPERS WITH RESOLUTION TO 0.001 INCH



# SIMULATION MODEL




Emphasis Network: 100Hz/500Hz/1590Hz (16dB @ 10kHz)

**1.** Determine the F3 frequency from the playback attenuation at 10kHz:

$$F3 = 10000 / (\sqrt{(1/((10^{(-dB/20)})^2)-1)})$$

where "F" is the -3dB frequency and "-dB" is the
10kHz attenuation entered as a negative number (see table on next page).

**2.** If the three time constants are known, proceed to step 4.

**3.** Calculate the time constants for each of the three turnover frequencies:

$T = 1 / 2\pi F$ (note also that $F = 1 / 2\pi T$)
For F1: $T = 1 / 2\pi * 100 = 1590\mu S$
For F2: $T = 1 / 2\pi * 500 = 318\mu S$
For F3: $T = 1 / 2\pi * 1590 = 100\mu S$

**4.** Calculate the resistor values for R1, R2 and R3:

T = RC, so:
T1 = (R1 + R2) * C1
T2 = R1 * C1
T3 = R3 * C2

R = T / C and C = 1nF
R1 = 318µS / 1nF = 318k
R2 = (1590µS / 1nF) – 318k = 1.272M
R3 = 100µS / 1nF = 100k

**5.** Adjust scaling of IcVs2 so 1kHz is at 0dB on the resulting graph.

# Treble Transition Frequencies
# for
# Common 10kHz Playback Attenuation Levels

| 10kHz Attenuation | Transition Frequency (& Time Constant) |
|---|---|
| -5dB | 6800Hz (23.41µS) |
| -8.5dB | 4056Hz (39.24µS) |
| -10dB | 3333Hz (47.75µS) |
| -10.5 | 3128Hz (50.88µS) |
| -12dB (AES) | 2595Hz (61.33µS) |
| -13.73dB (RIAA) | 2122Hz (75µS) |
| -14dB | 2036Hz (78.17µS) |
| -15dB | 1807Hz (88.08µS) |
| -16dB (NAB and Columbia LP) | 1591.55Hz (100.0µS) |
| -20dB | 1005Hz (158.36µS) |

(The formula for converting –dB at 10kHz to the –3dB frequency was generously provided by *audioXpress* Regular Contributor G.R. Koonce.)



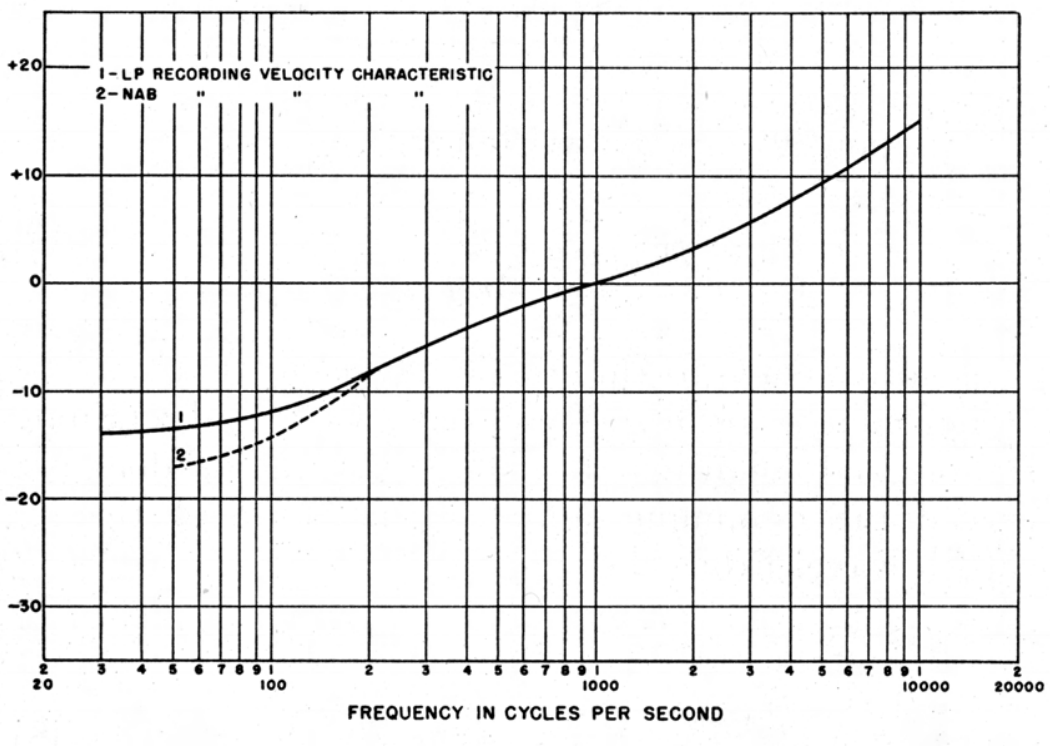
NOTE: THE TREBLE BOOST (IN RECORD) OR ROLLOFF (IN PLAYBACK) CAN BE SPECIFIED 3 DIFFERENT WAYS:

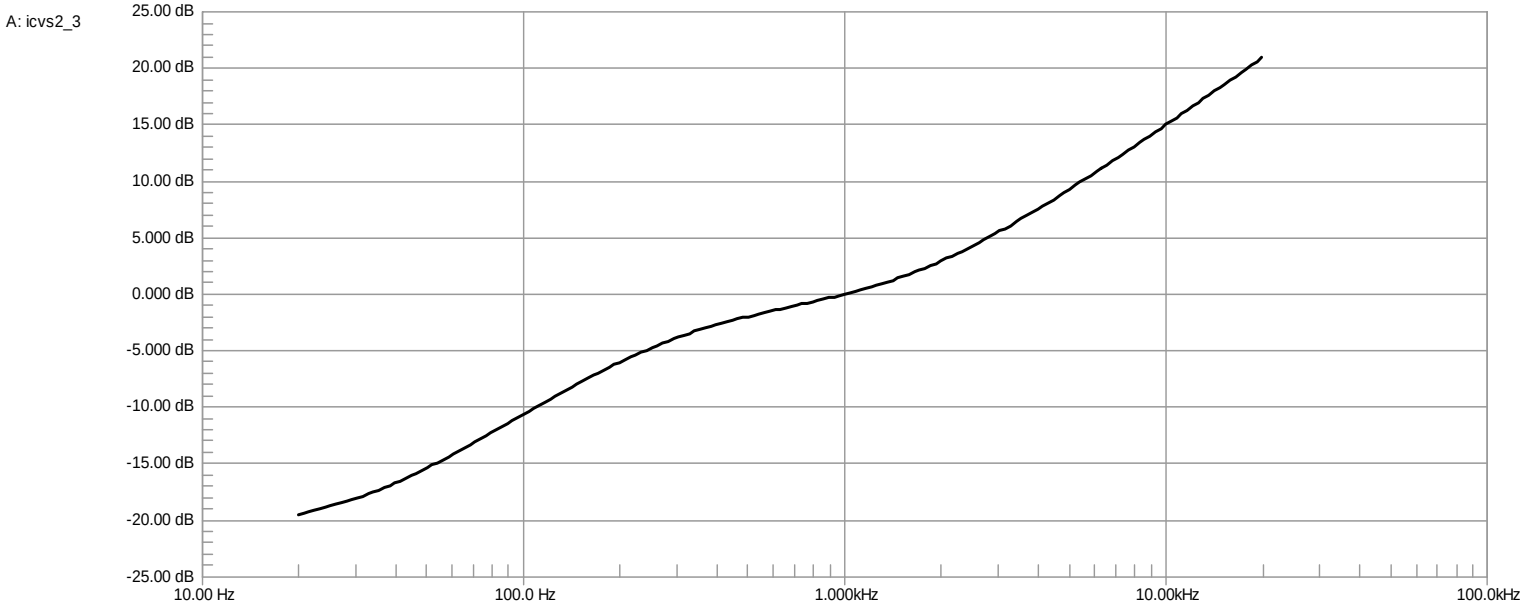
1. + (RECORD) OR – dB (PLAYBACK) AT 10kHz.

2. THE ACTUAL TRANSITION FREQUENCY (+/-3dB FREQUENCY).

3. THE TIME CONSTANT ASSOCIATED WITH THE TRANSITION FREQUENCY.

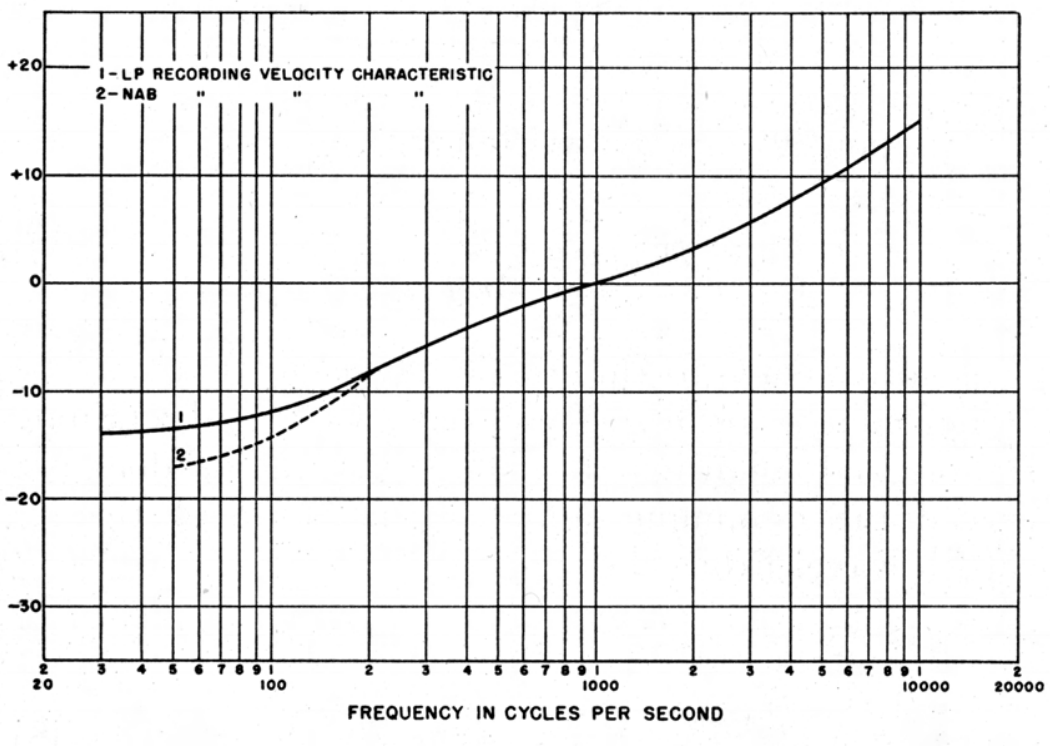
# SIMULATION: 30Hz / 300Hz / 1590Hz
# (5305µS / 530.5µS / 100µS)

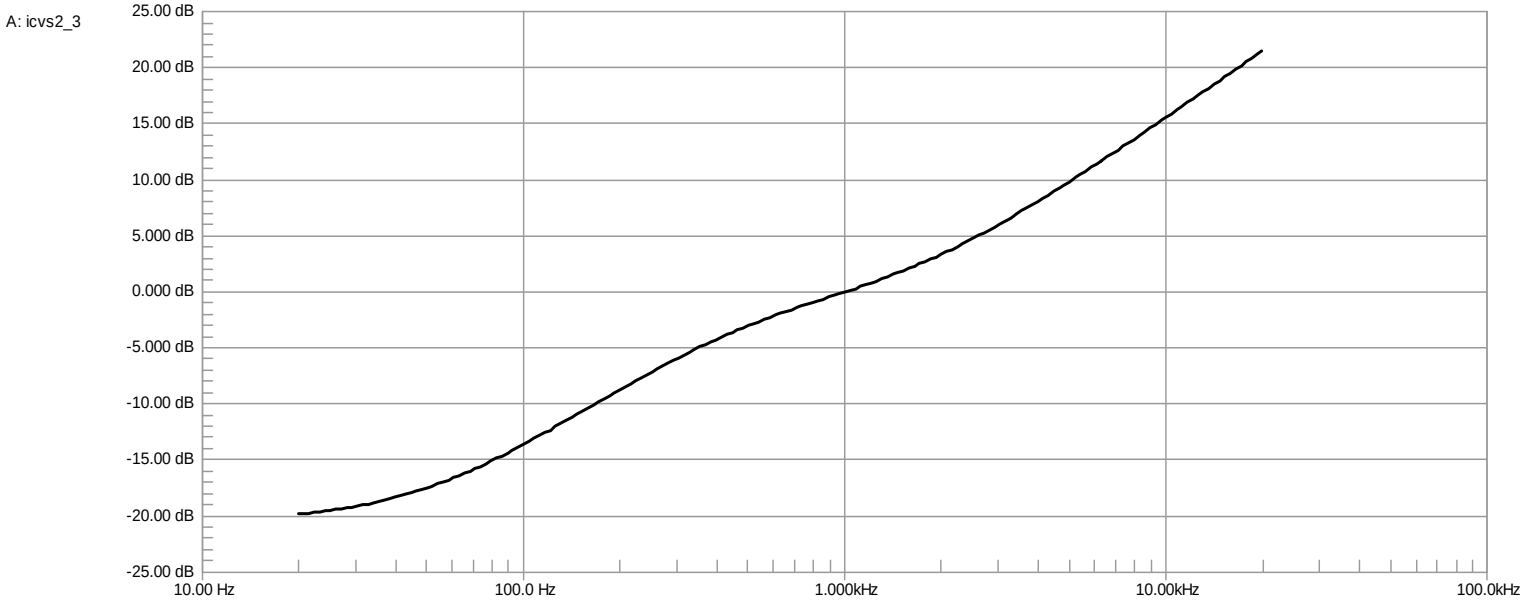



| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | -14.00dB | -18.1dB | 4.10dB |
| 50Hz | -13.55dB | -15.4dB | 1.85dB |
| 100Hz | -11.87dB | -10.7dB | 1.17dB |
| 200Hz | -8.38dB | -6.0dB | 2.38dB |
| 500Hz | -2.86dB | -2.0dB | 0.86dB |

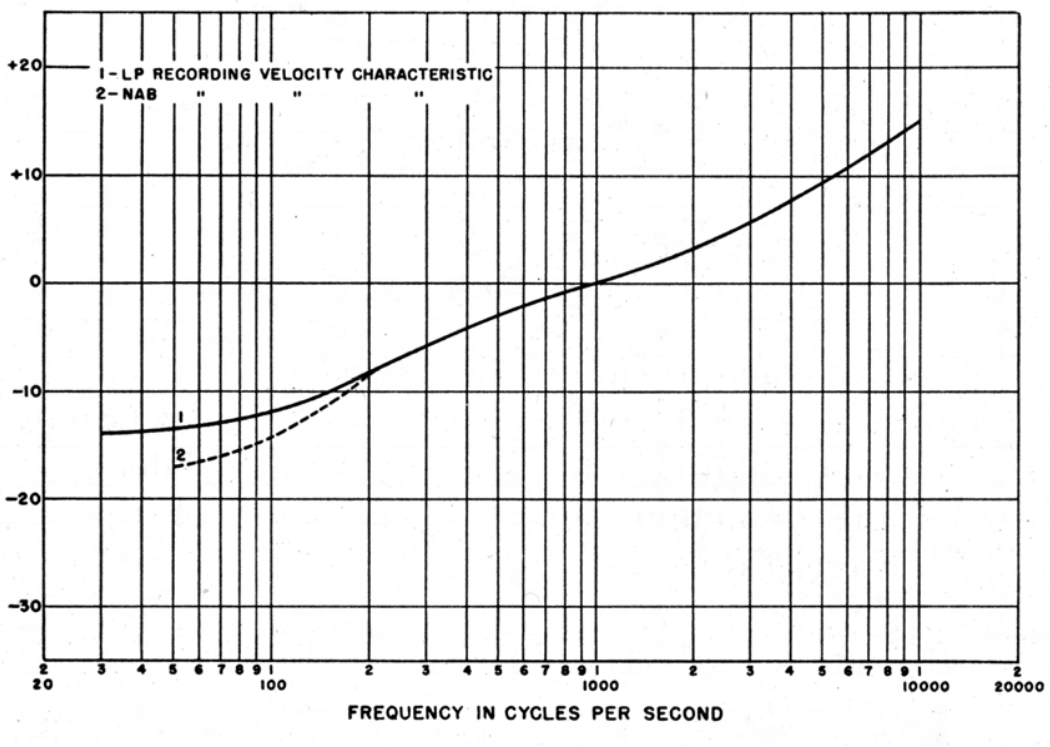
# SIMULATION: 50Hz / 500Hz / 1590Hz
# (3180µS / 318µS / 100µS)

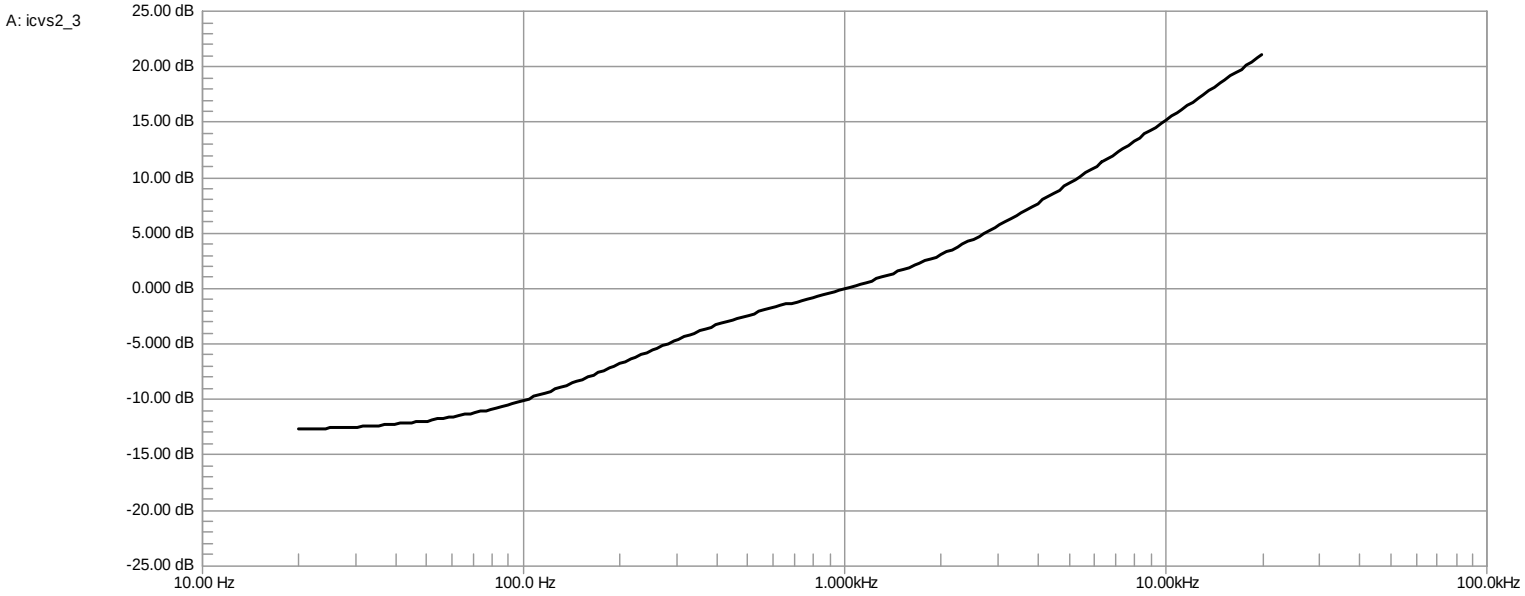



| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | -14.00dB | -19.2dB | 5.20dB |
| 50Hz | -13.55dB | -17.5dB | 3.95dB |
| 100Hz | -11.87dB | -13.7dB | 1.83dB |
| 200Hz | -8.38dB | -8.8dB | 0.42dB |
| 500Hz | -2.86dB | -3.0dB | 0.14dB |

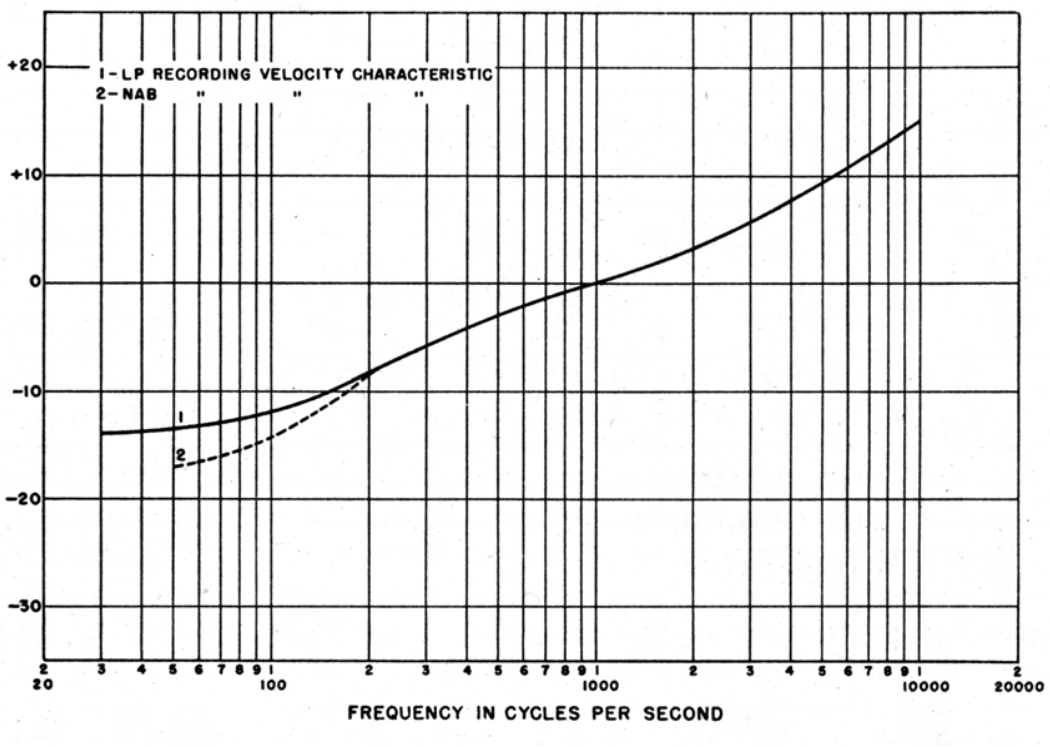
# SIMULATION: 100Hz / 398Hz / 1590Hz
# (Copeland 1590µS / 400µS / 100µS)

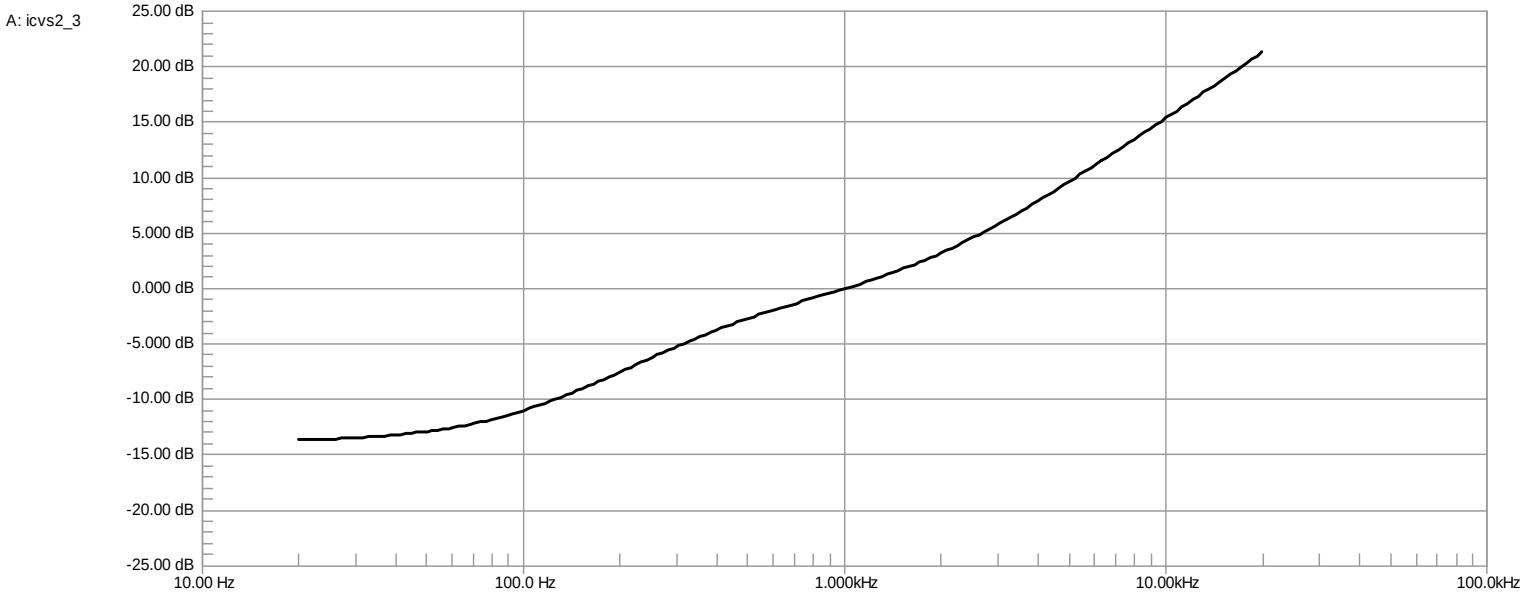



| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | -14.00dB | -12.5dB | 1.50dB |
| 50Hz | -13.55dB | -11.9dB | 1.65dB |
| 100Hz | -11.87dB | -10.1dB | 1.77dB |
| 200Hz | -8.38dB | -6.8dB | 1.58dB |
| 500Hz | -2.86dB | -2.4dB | 0.46dB |

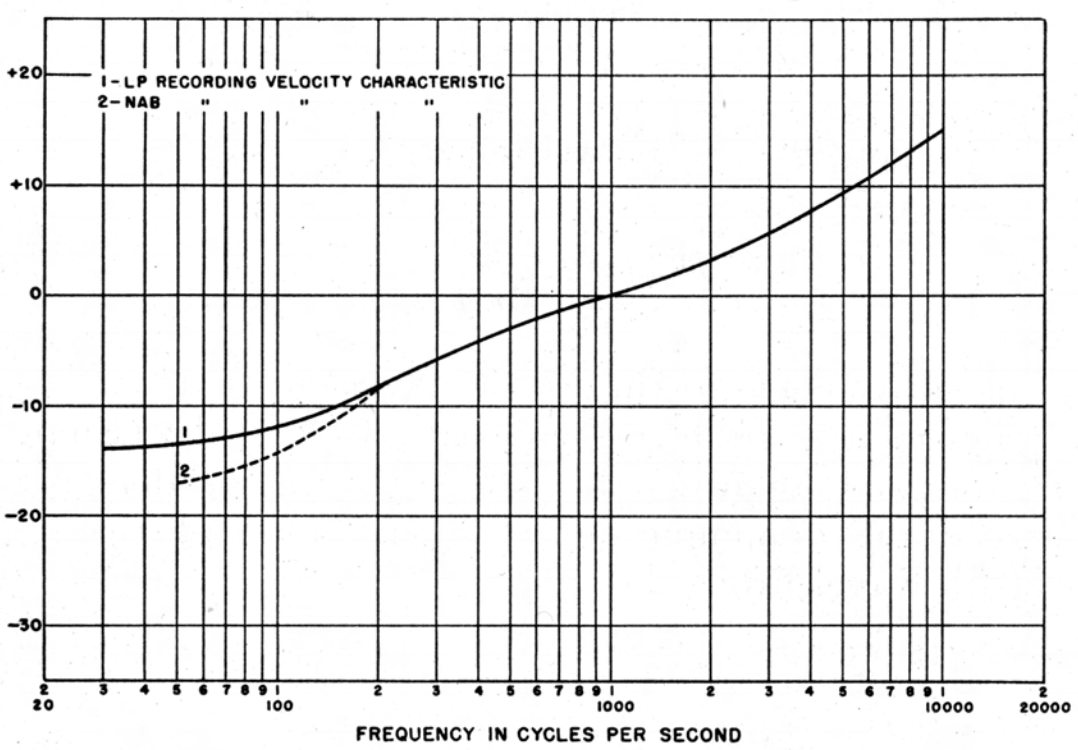
# SIMULATION: 100Hz / 455Hz / 1590Hz
# (Copeland 1590µS / 350µS / 100µS)



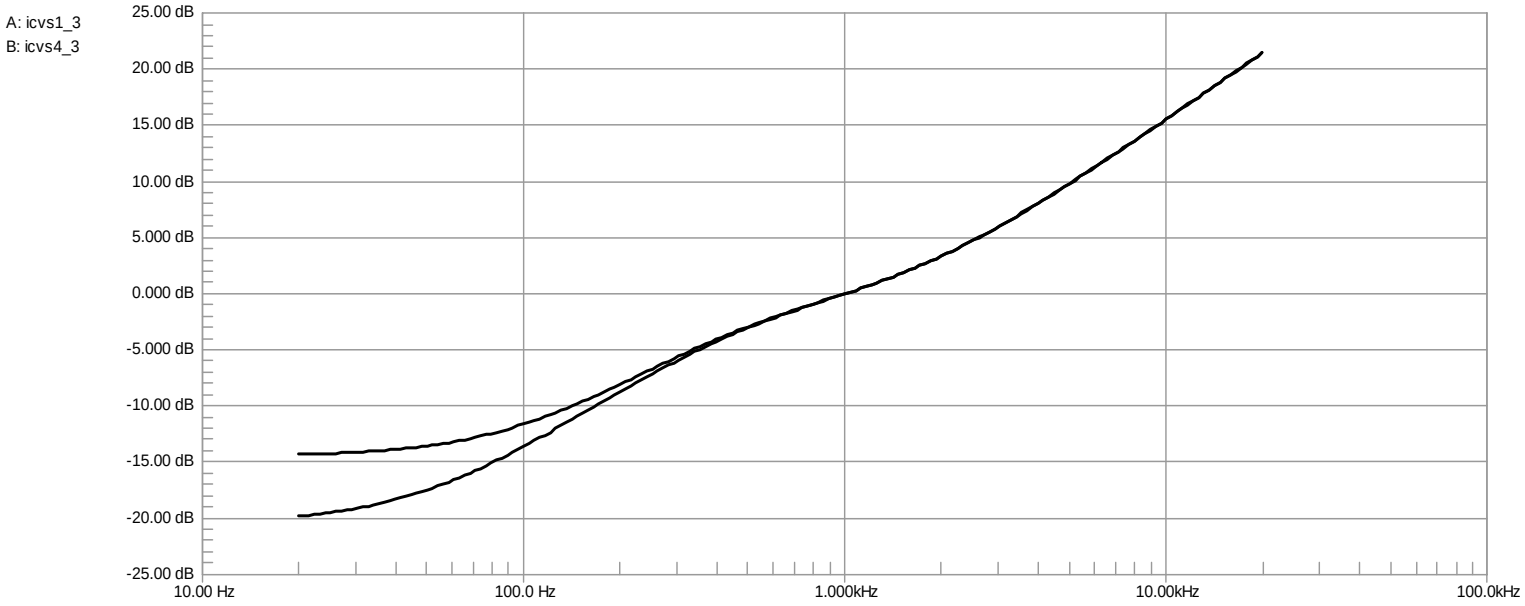




| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | -14.00dB | -13.5dB | 0.50dB |
| 50Hz | -13.55dB | -12.9dB | 0.65dB |
| 100Hz | -11.87dB | -11.0dB | 0.87dB |
| 200Hz | -8.38dB | -7.5dB | 0.88dB |
| 500Hz | -2.86dB | -2.7dB | 0.16dB |

# SIMULATION: 100Hz / 500Hz / 1590Hz
# (50Hz / 500Hz / 16dB @ 10kHz for NAB)




**BELOW 200Hz: TOP CURVE IS COLUMBIA; LOWER CURVE IS NAB**




| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | -14.00dB | -14.1dB | 0.10dB |
| 50Hz | -13.55dB | -13.6dB | 0.05dB |
| 100Hz | -11.87dB | -11.6dB | 0.27dB |
| 200Hz | -8.38dB | -8.1dB | 0.28dB |
| 500Hz | -2.86dB | -2.9dB | 0.04dB |

# SNEPVANGERS, et al. NAB CURVE

## 70.7Hz / 500Hz / 1590Hz
## (2250µS / 318µS /100 µS) (Refs. 14 & 15)

| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | N/A | -16.8dB | N/A |
| 50Hz | -17.2dB | -15.8dB | 1.4dB |
| 100Hz | -14.4dB | -12.9dB | 1.5dB |

## 62.5Hz / 500Hz / 1590Hz
## (2545µS / 318µS / 100µS) (Ref. 14)

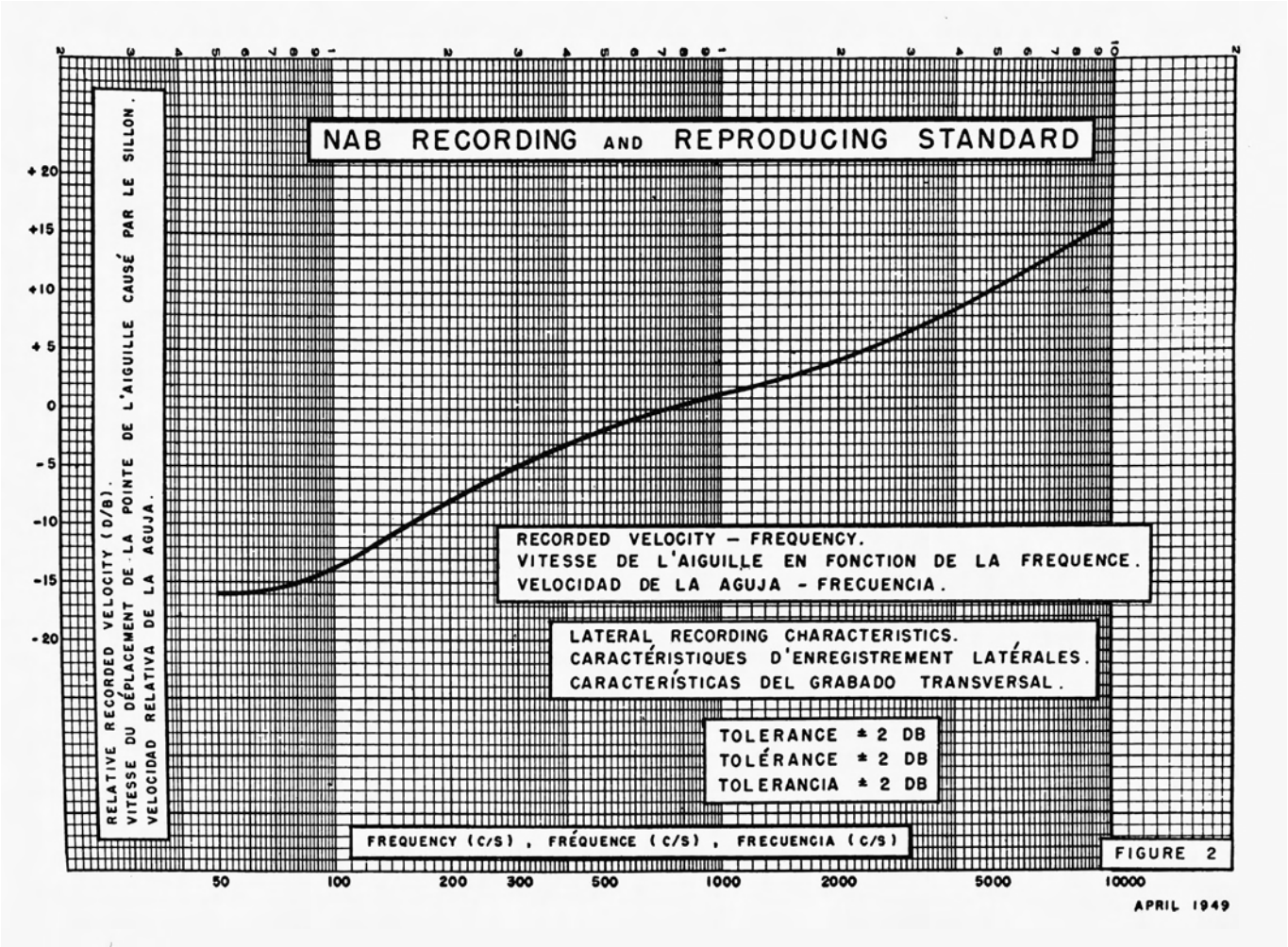
| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | N/A | -17.7dB | N/A |
| 50Hz | -17.2dB | -16.4dB | 0.8dB |
| 100Hz | -14.4dB | -13.2dB | 1.2dB |

## 50Hz / 500Hz / 1590Hz
## (3180µS / 318µS / 100µS)

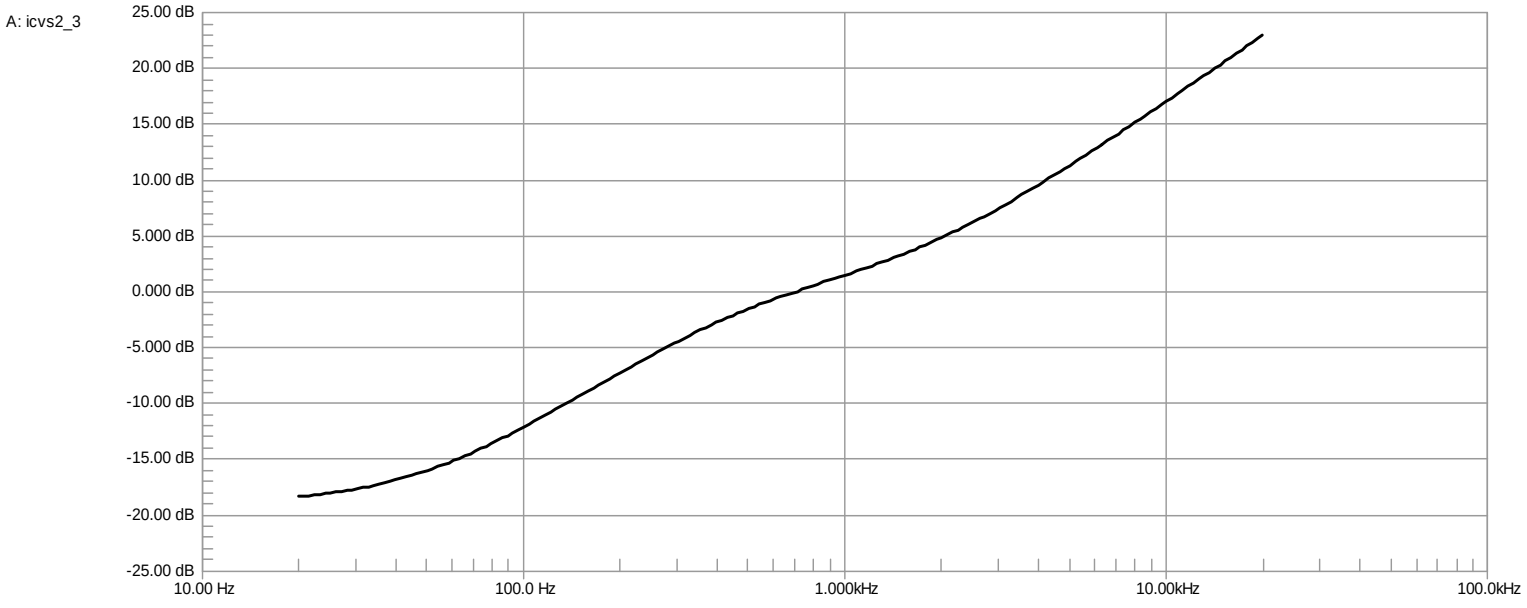
| | SNEPVANGERS et al. | THIS SIMULATION | ERROR |
|---|---|---|---|
| 30Hz | N/A | -19.2dB | N/A |
| 50Hz | -17.2dB | -17.5dB | 0.3dB |
| 100Hz | -14.4dB | -13.7dB | 0.7dB |

# NAB CURVE (Reed P. 242)

0dB Reference = 700Hz

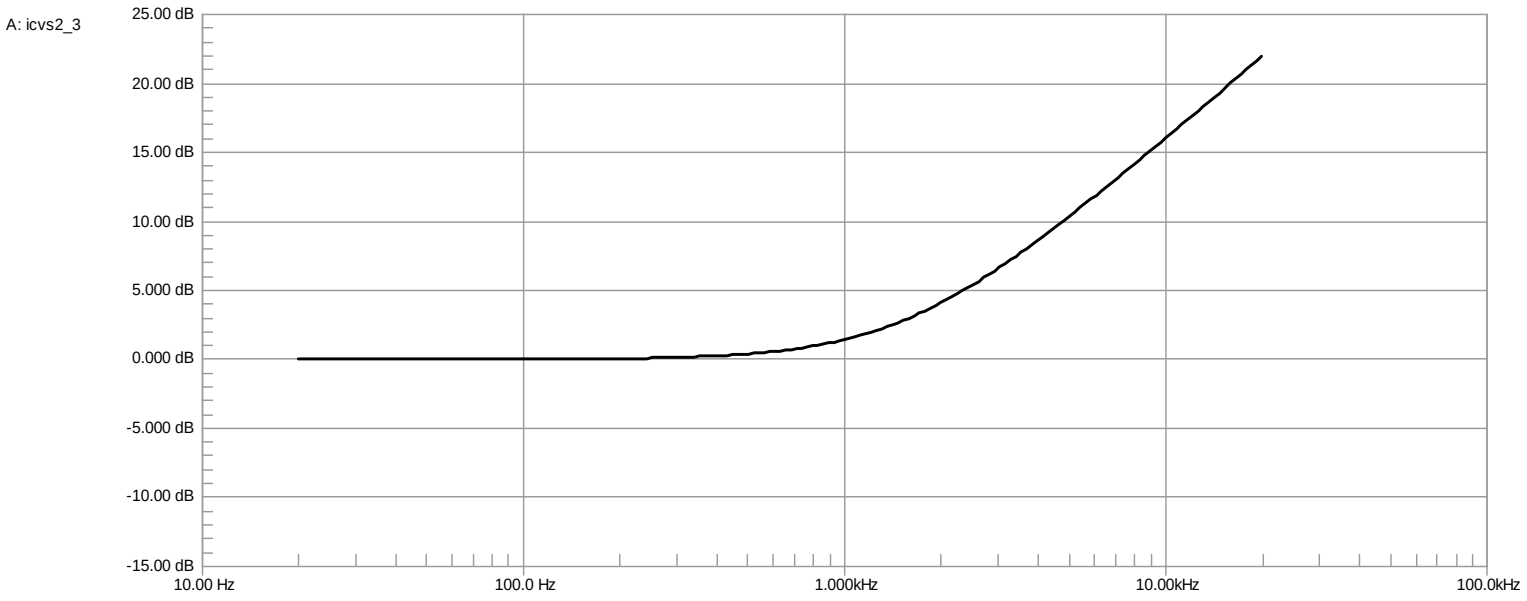



# SIMULATION: 3180µS / 318µS / 100µS with 0dB Ref. @ 700Hz (Snepvangers 50Hz / 500Hz / 1590Hz)



+16dB at 10kHz:
RELATIVE TO WHAT?

HIGH-FREQUENCY PRE-EMPHASIS SIMULATION:
100µs
+3dB @ 1590Hz
+16dB @ 10kHz




NOTE THE FOLLOWING:

1. +16dB @ 10kHz IS RELATIVE TO THE LOW END OF THE AUDIO SPECTRUM (20Hz), *NOT* 1kHz!!

2. 1kHz IS AT +1.4dB RELATIVE TO 20Hz.

3. WHEN THIS FILTER IS COMBINED WITH THE BASS PORTION OF THE CURVE, 10kHz OFTEN WON'T BE AT +16dB RELATIVE TO 1kHz.

4. EDUCATED GUESS: NAB MOVED THE 0dB REFERENCE TO 700Hz TO PUT 10kHz AT +16dB ON THE GRAPH, CAUSING UNTOLD CONFUSION EVER SINCE!

# NAB CURVE SIMULATIONS

0dB Reference = 700Hz

#1 = COPELAND: 2250µS / 275µs / 100µS
(70.7Hz / 578.7Hz / 1590Hz)

#2 = SNEPVANGERS: 3180µS / 318µS / 100µS
(50Hz / 500Hz / 1590Hz)

#3 = 2545µS / 318µS / 100µS
(62.5Hz / 500Hz/ 1590Hz) (Ref. 14)

#4 = 2250µS / 318µS /100 µS
(70.7Hz / 500Hz / 1590Hz) (Refs. 14 & 15)

DEVIATIONS FROM NAB GRAPH FOR #1, #2, #3 & #4
ARE IN PARENTHESES (X.XXdB)

| NAB GRAPH | | #1 | #2 |
|---|---|---|---|
| 50Hz | -15.99dB | -15.08dB (0.91dB) | -16.03dB (0.04dB) |
| 80Hz | -15.04dB | -13.30dB (1.74dB) | -13.58dB (1.46dB) |
| 100Hz | -13.79dB | -12.15dB (1.64dB) | -12.17dB (1.62dB) |
| 200Hz | -7.97dB | -7.69dB (0.28dB) | -7.28dB (0.69dB) |
| 500Hz | -1.85dB | -1.74dB (0.11dB) | -1.56dB (0.29dB) |
| 700Hz (Ref) | 0.00dB | 0.00dB | 0.00dB |
| 1kHz | +1.28dB | +1.66dB (0.38dB) | +1.49dB (0.21dB) |
| 2kHz | +4.16dB | +5.22dB (1.06dB) | +4.85dB (0.69dB) |
| 5kHz | +10.23dB | +11.76dB (1.53dB) | +11.34dB (1.11dB) |
| 10kHz | +16.15dB | +17.51dB (1.36dB) | +17.06dB (0.91dB) |
| | | (Avg. Error = 0.9dB) | (Avg. Error = 0.7dB) |

| NAB GRAPH | | #3 | #4 |
|---|---|---|---|
| 50Hz | -15.99dB | -14.97dB (1.02dB) | -14.29dB (1.70dB) |
| 80Hz | -15.04dB | -12.96dB (2.08dB) | -12.54dB (2.50dB) |
| 100Hz | -13.79dB | -11.71dB (2.08dB) | -11.40dB (2.39dB) |
| 200Hz | -7.97dB | -7.14dB (0.83dB) | -7.05dB (0.92dB) |
| 500Hz | -1.85dB | -1.55dB (0.30dB) | -1.54dB (0.31dB) |
| 700Hz (Ref) | 0.00dB | 0.00dB | 0.00dB |
| 1kHz | +1.28dB | +1.48dB (0.2dB) | +1.48dB (0.2dB) |
| 2kHz | +4.16dB | +4.84dB (0.68dB) | +4.84dB (0.68dB) |
| 5kHz | +10.23dB | +11.32dB (1.09dB) | +11.31dB (1.08dB) |
| 10kHz | +16.15dB | +17.05dB (0.9dB) | +17.05dB (0.9dB) |

# *Dialing Your Disks*

Records are made with the treble range boosted to mask surface noise, and the bass range reduced in volume to conserve groove space and reduce distortion. When the records are played, therefore, treble must be reduced and bass increased to restore the original balance. Control positions on equalizers are identified in different ways, but equivalent markings are listed at the top of each column in the table below. This table covers most of the records sold in America during the past few years, with the emphasis on LP. Some older LPs and 78s required 800-cycle turnover; some foreign 78s are recorded with 300-cycle turnover and zero or 5-db treble boost. One-knob equalizers should be set for proper turnover, and the treble tone control used for further correction if required. In all cases, the proper settings of controls are those that sound best.

| | TURNOVER | | | ROLLOFF AT 10KC. | |
|---|---|---|---|---|---|
| | 400 | 500 RIAA RCA ORTHO NAB NARTB | 500 (MOD.) LP COL ORIG. LP | 10.5-13.5 db AES NARTB RCA ORTHO RIAA | 16 db NAB(old) COL LP ORIG. LP |
| RECORD LABEL | AES (old) | AES (new) | LON | LON | |
| Allied | | ● | | ● | |
| Angel | | ● | | ● | |
| Atlantic*[1] | | ● | | | ● |
| Amer. Rec. Soc.* | | ● | | ● | |
| Bartok | | ● | | | ● |
| Blue Note Jazz* | ● | | | ● | |
| Boston* | | | ● | | ● |
| Caedmon | | ● | | ● | |
| Canyon* | ● | | | ● | |
| Capitol* | ● | | | ● | |
| Capitol-Cetra | ● | | | ● | |
| Cetra-Soria | | | ● | | ● |
| Colosseum* | | | ● | | ● |
| Columbia* | | | ● | | ● |
| Concert Hall* | ● | | | ● | |
| Contemporary* | ● | | | ● | |
| Cook (SOOT)[1] | | ● | | ● | |
| Decca* | ● | | ● | | ● |
| EMS* | ● | | | ● | |
| Elektra | | ● | | | ● |
| Epic* | | | ● | | ● |
| Esoteric | | ● | | ● | |
| Folkways (most) | | ● | | | ● |
| Good-Time Jazz* | ● | | | ● | |
| Haydn Soc.* | | | ● | | ● |
| L'Oiseau-Lyre* | | | ● | ● | |
| London* | | | ● | ● | |
| Lyrichord, new*[2] | | ● | | | ● |
| Mercury* | ● | | | ● | |
| MGM | | ● | | ● | |
| Montilla | | ● | | ● | |
| Oceanic* | | ● | | | ● |
| Pacific Jazz | | ● | | ● | |
| Philharmonia* | ● | | | ● | |
| Polymusic*[1] | | ● | | | ● |
| RCA Victor | | ● | | ● | |
| Remington* | | ● | | | ● |
| Riverside | | ● | | ● | |
| Romany | | ● | | ● | |
| Savoy | | ● | | ● | |
| Tempo | | ● | | ● | |
| Urania, most* | | ● | | | ● |
| Urania, some | ● | | | ● | |
| Vanguard* | | | ● | | ● |
| Bach Guild* | | | ● | | ● |
| Vox* | | | ● | | ● |
| Walden | | ● | | ● | |
| Westminster | | ● | | | ● |

*Beginning sometime in 1954, records made from new masters require RIAA equalization for both bass and treble.

[1]"Binaural" records produced on this label are recorded to NARTB standards on the outside band. On the inside band, NARTB is used for low frequencies but the treble is recorded flat, without pre-emphasis.

[2]Some older releases used the old Columbia curve, others old AES.



High Fidelity Magazine - Sept. 1955

# *Dialing Your Disks*

All LP disks are recorded with treble boost and bass cut, the amount of which often varies from one manufacturer to another. To play a disk, the bass below a certain turnover frequency must be boosted, and the treble must be rolled off a certain number of decibels at 10,000 cycles. Recommended control settings to accomplish this are listed for each manufacturer. Equalizer control panel markings correspond to the following values in the table below: ROLL-OFF — 10.5: LON, FFRR. 12: AES, RCA, Old RCA. 13.7: RIAA, RCA, New RCA, New AES, NARTB, ORTHOphonic. 16: NAB, LP, COL, COL LP, ORTHOcoustic. TURNOVER — 400: AES, RCA. 500C: LP, COL, COL LP, Mod NAB, LON, FFRR. 500R: RIAA, ORTHOphonic, NARTB, New AES. 500: NAB: 630: BRS. 800: Old RCA.

| RECORD LABEL | NEW | | OLD |
|---|---|---|---|
| | *Turnover* | *Rolloff* | *Record No. or Date: Turnover, Rolloff* |
| Allied | 500 | 16 | |
| Amer. Rec. Soc. | 400 | 12 | |
| Angel | 500R | 13.7 | |
| Arizona | 500R | 13.7 | To 1955: 400, 12.7 |
| †Atlantic | 500R | 13.7 | |
| Audiophile | 500 | 12 | |
| Bach Guild | 500R | 13.7 | No. 501-529: 500, 16 |
| *Bartok | 500R | 13.7 | No. 901-905, 308, 310, 311: 500R, 13.7<br>No. 906-920, 301-307, 309: 630, 16 |
| Bethlehem | 500R | 13.7 | |
| Blue Note Jazz | 500R | 13.7 | To 1955: 400, 12 |
| Boston | 500C | 16 | |
| *Caedmon | 500R | 13.7 | No. 1001-1022: 630, 16 |
| Canyon | 400 | 12 | |
| Capitol | 500R | 13.7 | To 1955: 400, 12.7 |
| Capitol-Cetra | 500R | 13.7 | To 1955: 400, 12.7 |
| Cetra-Soria | 500C | 16 | |
| Classic Editions | 500R | 13.7 | |
| Colosseum | 500R | 13.7 | To January 1954: 500, 16 |
| *Columbia | 500R | 13.7 | To 1955: 500C, 16. |
| Concert Hall | 500R | 10.5 | To 1954: 500C, 16. |
| *Contemporary | 500R | 13.7 | No. 3501, 2501, 2502, 2505, 2507, 2001, 2002: 400, 12. No. 2504: 500, 16 |
| †Cook (SOOT)* | 500 | 12-15 | |
| Coral | 500 | 16 | |
| Decca | 500 | 16 | |
| Elektra | 500R | 13.7 | No. 2-15, 18-20, 24-26: 630, 16. No. 17, 22:400, 12. No. 16, 21, 23, 24: 500R, 13.7 |
| EMS | 500R | 13.7 | |
| Epic | 500R | 13.7 | |
| Esoteric | 500R | 13.7 | No. ES 500, 517, EST 5, 6: 400, 12 |
| Folkways | 500C | 16 | |
| *Good-Time Jazz | 500R | 13.7 | No. 1, 5-8: 500, 16. No. 3, 9-19: 400, 12 |
| Haydn Society | 500C | 16 | |
| HMV | 500R | 16 | |
| Kapp | 500R | 13.7 | No. 100-103, 1000-1001: 800, 16 |
| Kendall | 500 | 16 | |
| *London | 500R | 13.7 | To No. 846: 500C, 10.5 |
| Lyrichord | 500 | 16 | |
| McIntosh | 500R | 13.7 | |
| *Mercury | 500R | 13.7 | To October 1954: 400, 12 |
| MGM | 500 | 12 | |
| Montilla | 500R | 13.7 | |
| New Jazz | 500R | 13.7 | |
| Nocturne | 500R | 13.7 | No. LP 1-3, 5, XP1-10: 400, 12 |
| Oceanic | 500C | 16 | |
| L'Oiseau-Lyre | 500R | 13.7 | To 1954: 500C, 10.5 |
| Overtone | 500R | 13.7 | No. 1-3: 500, 16 |
| Oxford | 500C | 16 | |
| Pacific Jazz | 500R | 13.7 | No. 1-13: 400, 12 |
| Philharmonia | 400 | 12 | |
| †Polymusic | 500 | 16 | |
| Prestige | 500R | 13.7 | |
| RCA Victor | 500R | 13.7 | To 1953: 800, 12. To 1954: 400, 12 |
| Remington | 500 | 16 | |
| Riverside | 500R | 13.7 | To 1955: 400, 12 |
| Romany | 500R | 13.7 | |
| Savoy | 500R | 13.7 | |
| Tempo | 500 | 16 | |
| Transradio | 500C | 16 | |
| Urania | 500 | 16 | No. 7059, 224, 7066, 7063, 7065, 603, 7069: 400, 12 |
| Vanguard | 500R | 13.7 | No. 411-442, 6000-6018, 7001-7011, 8001-8004: 500, 16 |
| Vox | 500R | 13.7 | To October 1954: 500, 16 |
| Walden | 500R | 13.7 | |
| Westminster | 500C | 16 | If AES specified: 400, 12 |

*Currently re-recording old masters for RIAA curve.
†Binaural records produced on this label have no treble boost on the inside band, which should be played without any rolloff.



High Fidelity Magazine - Oct. 1955


COLUMBIA BLUE LABEL: 1948-1955
(OTHER COLORS INCLUDED GREEN FOR
LIGHTER CLASSICAL MATERIAL;
RED, GRAY AND WHITE FOR POPULAR)

OLD COLUMBIA CURVE: CATALOG ML 4895, MATRIX XLP 3200
RIAA: AFTER MATRIX XLP 3200 (ESOTERIC SOUND)


COLUMBIA GRAY “6-EYES” LABEL: INTRODUCED IN 1955
(MOST POPULAR LABELS WERE RED)

ALL SHOULD BE RIAA

# CONCLUSIONS

**1.** The Columbia Lp Curve used Time Constants of
1590µS, 318µS and 100µS,
corresponding to turnover frequencies of
100Hz, 500Hz and 1590Hz (+/-16dB @ 10kHz).

This is the only combination that produces a graph matching Goldmark, Snepvangers & Bachman.

**2.** The closest fit to the published NAB graph is
3180µS, 318µS and 100µS,
Corresponding to turnover frequencies of
50Hz, 500Hz and 1590Hz (+/-16dB @ 10kHz).

The only difference between the NAB curve and the Columbia Lp Curve is the low-bass turnover point, F1.

NAB's decision to put the 0dB reference
at 700Hz rather than 1kHz is irrelevant.

## References


1. Galo, Gary A. “Disc Recording Equalization Demystified” in *ARSC Journal*, Fall 1996, Pp. 188-211. Reprinted in *The LP is Back*, 2nd Edition, Peterborough, NH: Audio Amateur Press, 2000, Pp. 44-54 (The reprint is available on line at www.smartdev.com/chpt14.pdf [PDF version for download] or www.smartdev.com/RIAA.html [text version].

2. Goldmark, Peter C., René Snepvangers and William S. Bachman. “The Columbia Long-Playing Microgroove Recording System.” In *Proceedings of the I.R.E.*, Vol. 37, No. 8, August 1949, pp. 923-927. (Fig. 3: P. 926).

3. KAB Souvenir EQS MK12 Disc Remastering Phono Preamp, Owner’s Manual, (www.kabusa.com).

4. Galo, Gary A. “Product Review – The KAB (EQS MK12) Preamp” in *audioXpress* Magazine, October 2002, Pp. 44-51. (PDF version available on line at www.kabusa.com).

5. “Disc Recording” and “Cutting Heads” in *Audio Cyclopedia*, 2nd ed. by Howard M. Tremaine. Indianapolis: Howard W. Sams & Co., 1969.

6. Copeland, Peter. “Chapter 5” from a possibly unpublished manuscript dated 3 September 2004 (Courtesy of Doug Pomeroy).

7. “Reproduction from Records” (Chapter 17) in *Radiotron Designer’s Handbook*, 4th ed. by Fritz Langford-Smith. Sydney, Australia: Amalgamated Wireless Valve Company Pty. Ltd., 1953, Pp. 727-732. (Available on CD-ROM from Old Colony Sound Lab, P.O. Box 243, Peterborough, NH 03458-0243, 603.924.6371, www.audioxpress.com/bksprods/products/cdrdh.htm).

8. McIntosh C-8 Preamplifier Owners Manual and Equalization Chart. Binghamton, NY: McIntosh Laboratory, Inc., 1956. (Revision 1, 12/20/1956, SN 10600 and up; PDF scans can be downloaded at www.one-electron.com/FC_Consumer.html).

9. Powell, James. R. *The Audiophile’s Technical Guide to 78 RPM, Transcription, and Microgroove Recordings*. Portage, MI: Gramophone Adventures, 1992. (Available from Nauck’s Vintage Records at www.78rpm.com).

10. “Dialing Your Discs” in *High Fidelity* Magazine, Sept. 1955, P. 58 (old chart) and Oct. 1955, P. 112 (revised chart).

11. Esoteric Sound Rek-O-Kut Re-Equalizer II, Operating Manual (PDF version available on line at www.esotericsound.com/REQ2MAN.pdf).

12. “Disc Recording and Reproduction” in *Sound Recording* by John Eargle. New York: van Nostrand Rheingold Company, 1980.

13. “Proposed NAB Recording and Reproducing Standards” (Chapter 19) in *The Recording and Reproduction of Sound* by Oliver Reed. Indianapolis, IN: Howard W. Sams & Co., Inc. (April 1949 NAB Curve is reproduced on p. 242).

14. “Reproduction Characteristics.” Spreadsheet at www7a.biglobe.ne.jp/~yosh/equalizations.xls.

15. homepage3.nifty.com/hirotac/memorandom-f/eq.html. This Japanese web page has a variety of disc EQ data, some of which is in English.