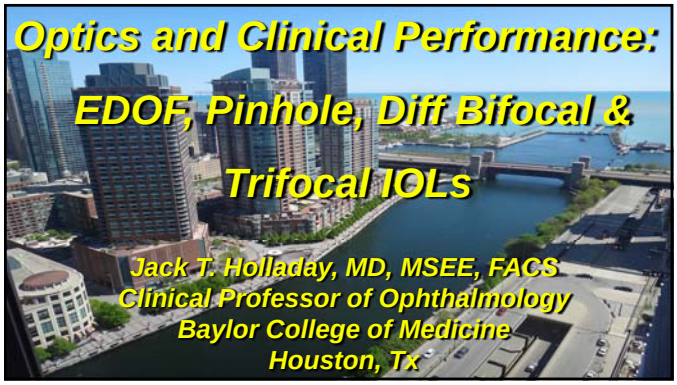
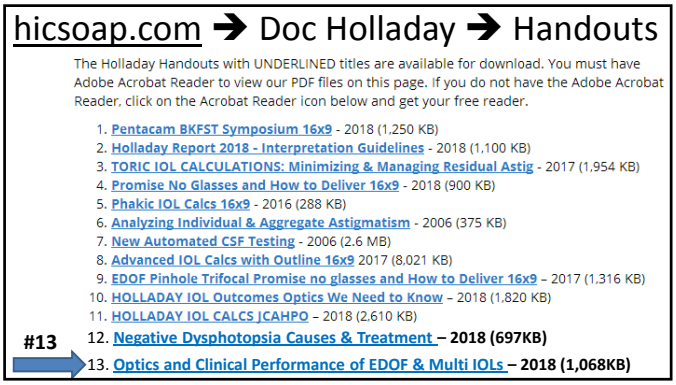
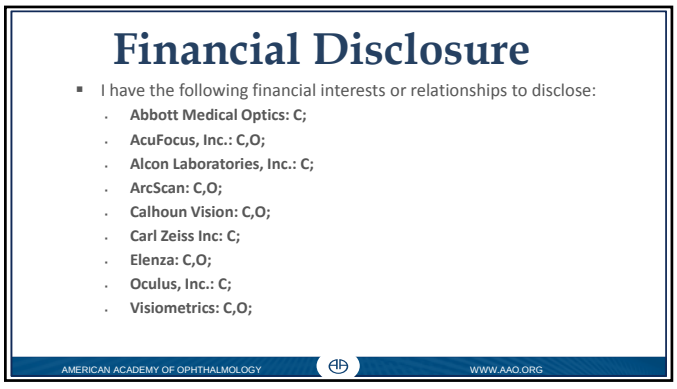
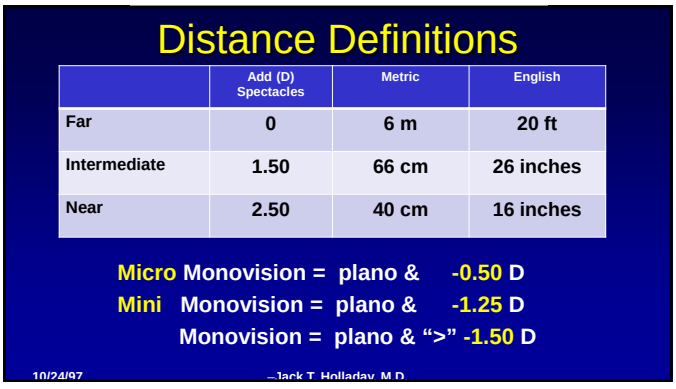

Optics and Clinical Performance:
EDOF, Pinhole, Diff Bifocal &
Trifocal IOLs
Jack T. Holladay, MD, MSEE, FACS
Clinical Professor of Ophthalmology
Baylor College of Medicine
Houston, Tx

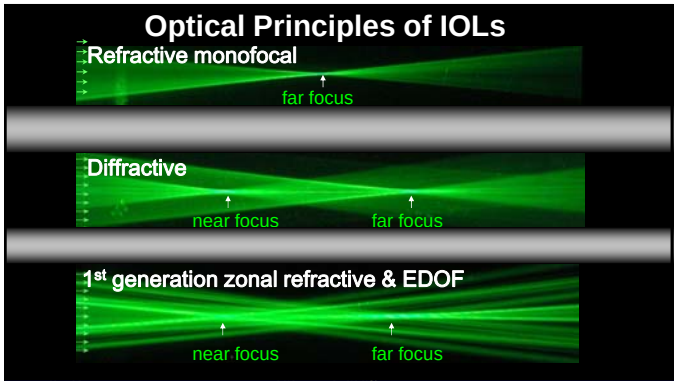
You can't get something
for nothing!
Tradeoffs & Compromise
Jack T. Holladay, MD, MSEE, FACS
Clinical Professor of Ophthalmology
Baylor College of Medicine
Houston, Tx

hicsoap.com
Doc Holladay/HANDOUTS
DUCTS
FAQS
MY ACCOUNT
DOC HOLLADAY
Biography
Holladay Publications
Holladay Handouts


hicsoap.com ➔ Doc Holladay ➔ Handouts
The Holladay Handouts with UNDERLINED titles are available for download. You must have Adobe Acrobat Reader to view our PDF files on this page. If you do not have the Adobe Acrobat Reader, click on the Acrobat Reader icon below and get your free reader.
1. Pentacam BKFST Symposium 16x9 - 2018 (1,250 KB)
2. Holladay Report 2018 - Interpretation Guidelines - 2018 (1,100 KB)
3. TORIC IOL CALCULATIONS: Minimizing & Managing Residual Astig - 2017 (1,954 KB)
4. Promise No Glasses and How to Deliver 16x9 - 2018 (900 KB)
5. Phakic IOL Calcs 16x9 - 2016 (288 KB)
6. Analyzing Individual & Aggregate Astigmatism - 2006 (375 KB)
7. New Automated CSF Testing - 2006 (2.6 MB)
8. Advanced IOL Calcs with Outline 16x9 2017 (8,021 KB)
9. EDOF Pinhole Trifocal Promise no glasses and How to Deliver 16x9 – 2017 (1,316 KB)
10. HOLLADAY IOL Outcomes Optics We Need to Know – 2018 (1,820 KB)
11. HOLLADAY IOL CALCS JCAHPO – 2018 (2,610 KB)
#13
12. Negative Dysphotopsia Causes & Treatment – 2018 (697KB)
13. Optics and Clinical Performance of EDOF & Multi IOLs – 2018 (1,068KB)


Financial Disclosure
I have the following financial interests or relationships to disclose:
Abbott Medical Optics: C;
AcuFocus, Inc.: C,O;
Alcon Laboratories, Inc.: C;
ArcScan: C,O;
Calhoun Vision: C,O;
Carl Zeiss Inc: C;
Elenza: C,O;
Oculus, Inc.: C;
Visiometrics: C,O;
AMERICAN ACADEMY OF OPHTHALMOLOGY
WWW.AAO.ORG


Distance Definitions
Add (D) Spectacles
Metric
English
Far
0
6 m
20 ft
Intermediate
1.50
66 cm
26 inches
Near
2.50
40 cm
16 inches
Micro Monovision = plano & -0.50 D
Mini Monovision = plano & -1.25 D
Monovision = plano & ">" -1.50 D
10/24/97
–Jack T. Holladay, M.D.

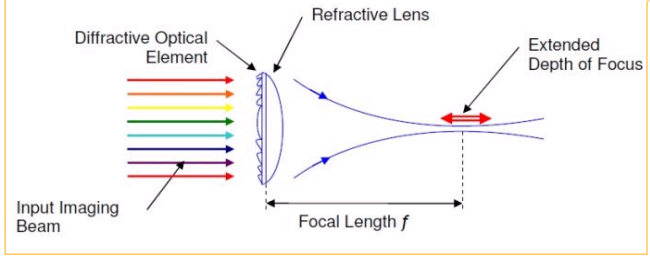



## How do we compare Optical Performance ?

1. High Contrast BDCVA @ distance (4 – 6 M)
2. High Contrast BDCVA @ intermed (66 cm)
3. High Contrast BDCVA @ near (40 cm)
4. Stereopsis (9/9 circles – 40 sec of arc)
5. Contrast Sensitivity Function (CSF)
6. Visual Disturbances (Halos, Glare, …)

10/24/97 –Jack T. Holladay, M.D.

## Extend Depth of Focus Lens

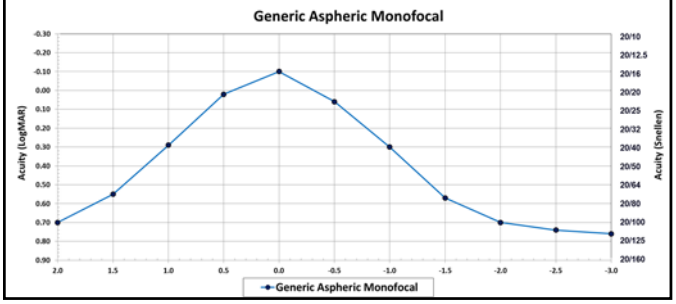



## IOL Optical Comparsion

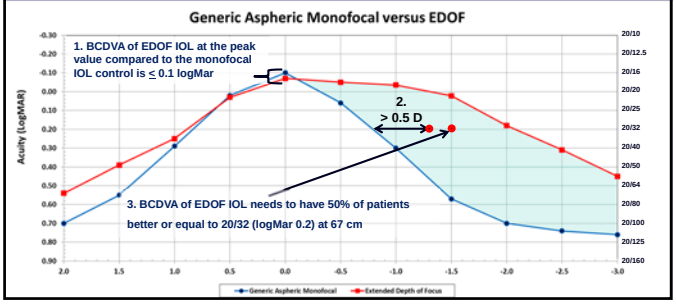
| IOL Type | Theoretical BSCVA | Actual BSCVA | Contrast Loss | Halos & Glare | Forward Light Scatter |
|---|---|---|---|---|---|
| Aspherical Mono | 20/09 | 20/17 | 0% | - | 0% |
| IC8 Pinhole IOL | 20/12 | 20/16 | 0% | - | 0% |
| EDF 1.50 D (1.00) | 20/16 | 20/18 | 20% | + | 10% |
| Diff Bifocal 3.00 D (2.00) | 20/20 | 20/22 | 25% | ++ | 18% |
| Diff Trif 3.75, 1.75 D (2.50, 1.25) | 20/20 | 20/22 | 30% | +++ | 18% |

LA Dodgers 1993-1995: 1.7% from 20/8.9 to 20/9.2
42% ≤ 20/12.5 AJO 1996; Oct 122 (4): 476-85.

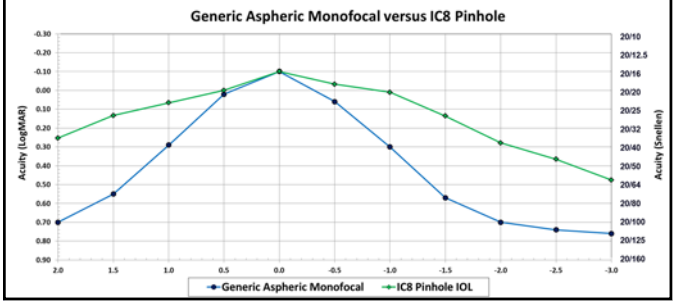
## Aspheric Mono



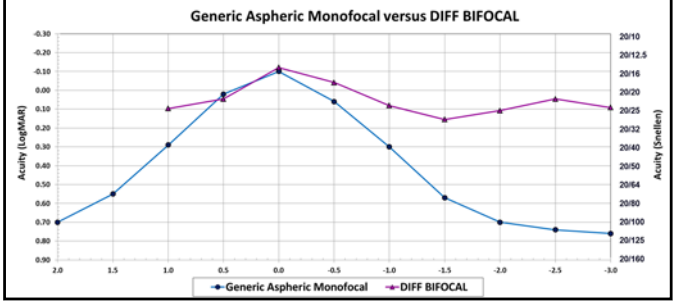

## Extend Depth of Focus Lens



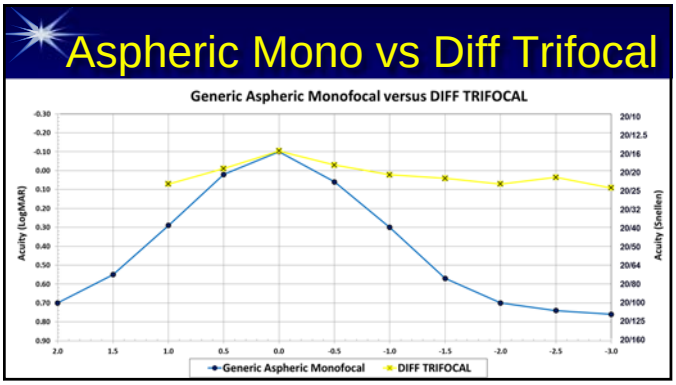
## Aspheric Mono vs IC8 Pinhole



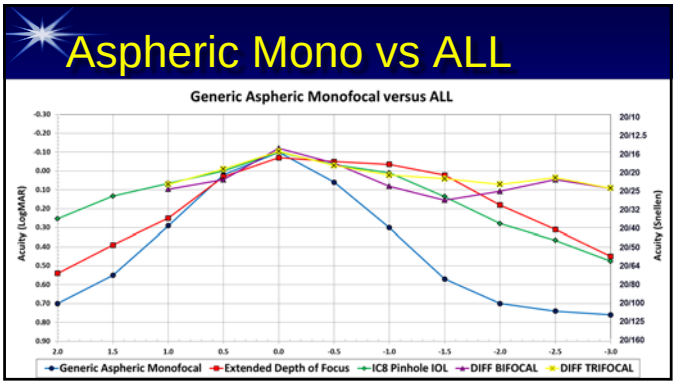

## Aspheric Mono vs Diff Bifocal



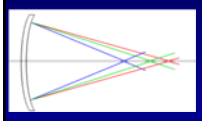
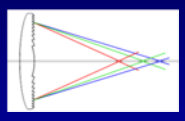
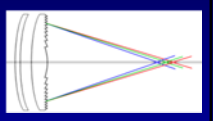

## Aspheric Mono vs Diff Trifocal




## Aspheric Mono vs ALL




## CORRECTION OF CHROMATIC ABERRATION

| Cornea | Lens with Achromatic Tech | Cornea+ Lens with Achromatic Tech |
|---|---|---|
|  |  |  |
| All corneas have a similar amount of chromatic aberration | Proprietary Achromatic Technology is optimized to counteract the chromatic aberration of the cornea | The net result is reduced chromatic aberration |

## *Duo Chrome Test*

**Hyperopic** **Myopic**

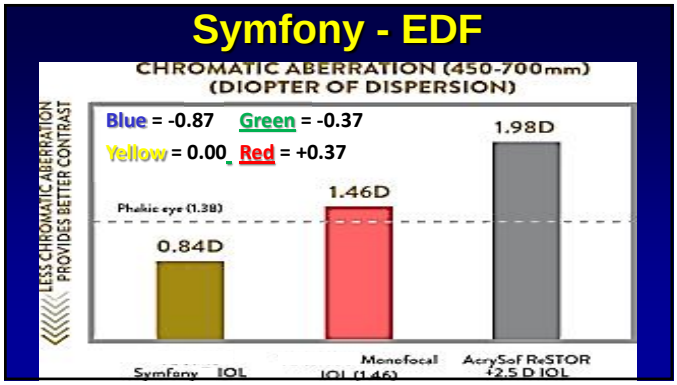
**N C K Z O**

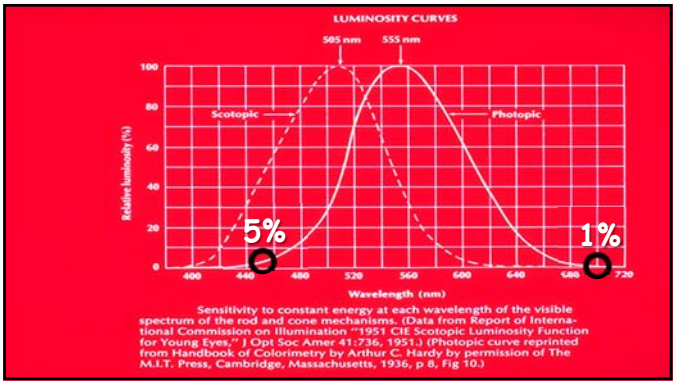
**R H S D K**

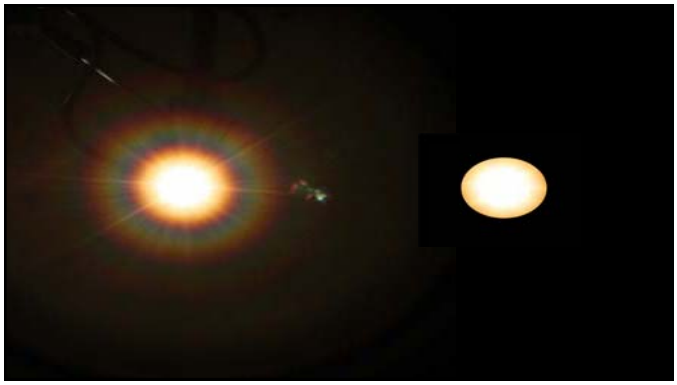
**D O V H R**

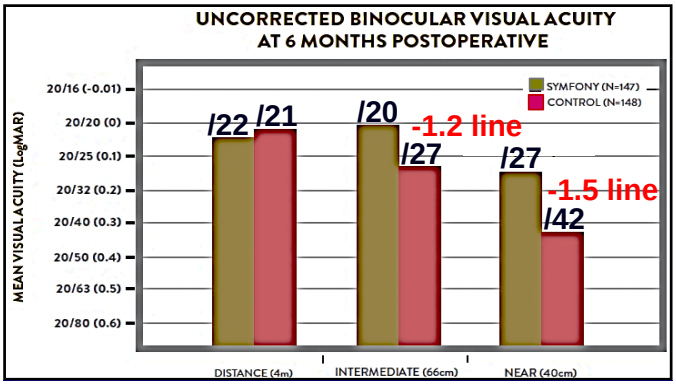
**C Z R H S**

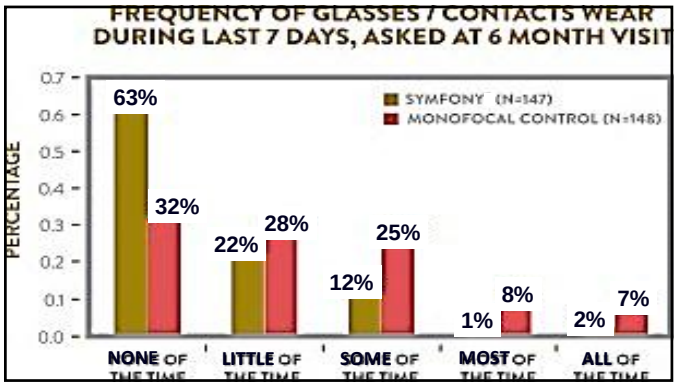
**O N H R C**


Symfony - EDF
CHROMATIC ABERRATION (450-700mm)
(DIOPTER OF DISPERSION)
LESS CHROMATIC ABERRATION PROVIDES BETTER CONTRAST
Blue = -0.87 Green = -0.37
Yellow = 0.00 Red = +0.37
Phakic eye (1.38)
0.84D
1.46D
1.98D
Symfony IOL
Monofocal IOL (1.46)
AcrySof ReSTOR +2.5 D IOL

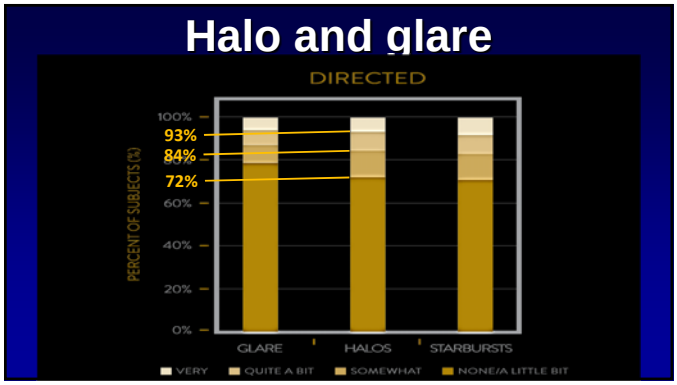

LUMINOSITY CURVES
505 nm
555 nm
Scotopic
Photopic
Relative luminosity (%)
5%
1%
Wavelength (nm)
Sensitivity to constant energy at each wavelength of the visible spectrum of the rod and cone mechanisms. (Data from Report of International Commission on Illumination "1951 CIE Scotopic Luminosity Function for Young Eyes," J Opt Soc Amer 41:736, 1951.) (Photopic curve reprinted from Handbook of Colorimetry by Arthur C. Hardy by permission of The M.I.T. Press, Cambridge, Massachusetts, 1936, p 8, Fig 10.)

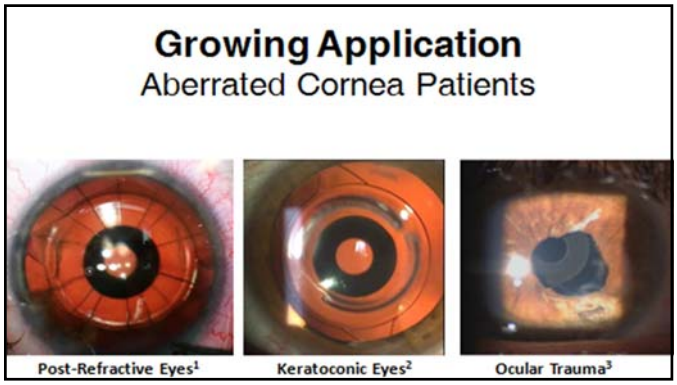


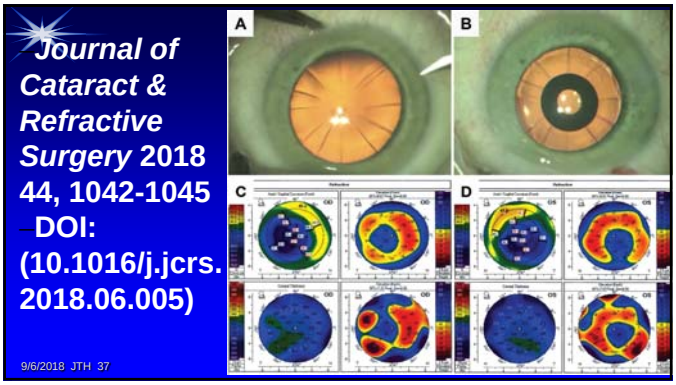

UNCORRECTED BINOCULAR VISUAL ACUITY
AT 6 MONTHS POSTOPERATIVE
SYMFONY (N=147)
CONTROL (N=148)
MEAN VISUAL ACUITY (LogMAR)
20/16 (-0.01)
20/20 (0)
20/25 (0.1)
20/32 (0.2)
20/40 (0.3)
20/50 (0.4)
20/63 (0.5)
20/80 (0.6)
/22
/21
/20
-1.2 line
/27
/27
-1.5 line
/42
DISTANCE (4m)
INTERMEDIATE (66cm)
NEAR (40cm)


FREQUENCY OF GLASSES / CONTACTS WEAR
DURING LAST 7 DAYS, ASKED AT 6 MONTH VISIT
SYMFONY (N=147)
MONOFOCAL CONTROL (N=148)
PERCENTAGE
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
63%
32%
22%
28%
12%
25%
1%
8%
2%
7%
NONE OF THE TIME
LITTLE OF THE TIME
SOME OF THE TIME
MOST OF THE TIME
ALL OF THE TIME

Diff Multi






| Presby Rx | Dom Eye DVA | Non-Dom Eye DVA | Binoc DVA | Dom Eye NVA | Non-Dom Eye NVA | Binoc NVA | 3D | CSF | Halo | Glare |
|---|---|---|---|---|---|---|---|---|---|---|
| Binocular Distance | 20/20 | 20/20 | **20/16** | 20/40 | 20/40 | **20/30** | **9** | **+40% +2dB** | -- | -- |
| Traditional Mono (1.5) | 20/20 | **20/40** | 20/20 | 20/40 | 20/25 | **20/25** | 6 | 0% | -- | -- |
| IC8 Pinhole | 20/20 | 20/20 | 20/20 | 20/40 | 20/30 | **20/30** | 8 | 0% | **Help** | **Help** |
| Extended DOF | 20/20 | 20/20 | 20/20 | 20/25 | 20/25 | **20/25** | 9 | -21% -1dB | **1+** | 11% |
| Diff Bifocal 2.5 D Add | 20/20 | 20/20 | 20/20 | 20/20 | 20/20 | **20/20** | 8 | -37% -2dB | **2+** | 18% |
| Diff Trifoc 3.0 D Add | 20/20 | 20/20 | 20/20 | 20/20 | 20/20 | **20/20** | 8 | -37% -2dB | **3+** | 18% |