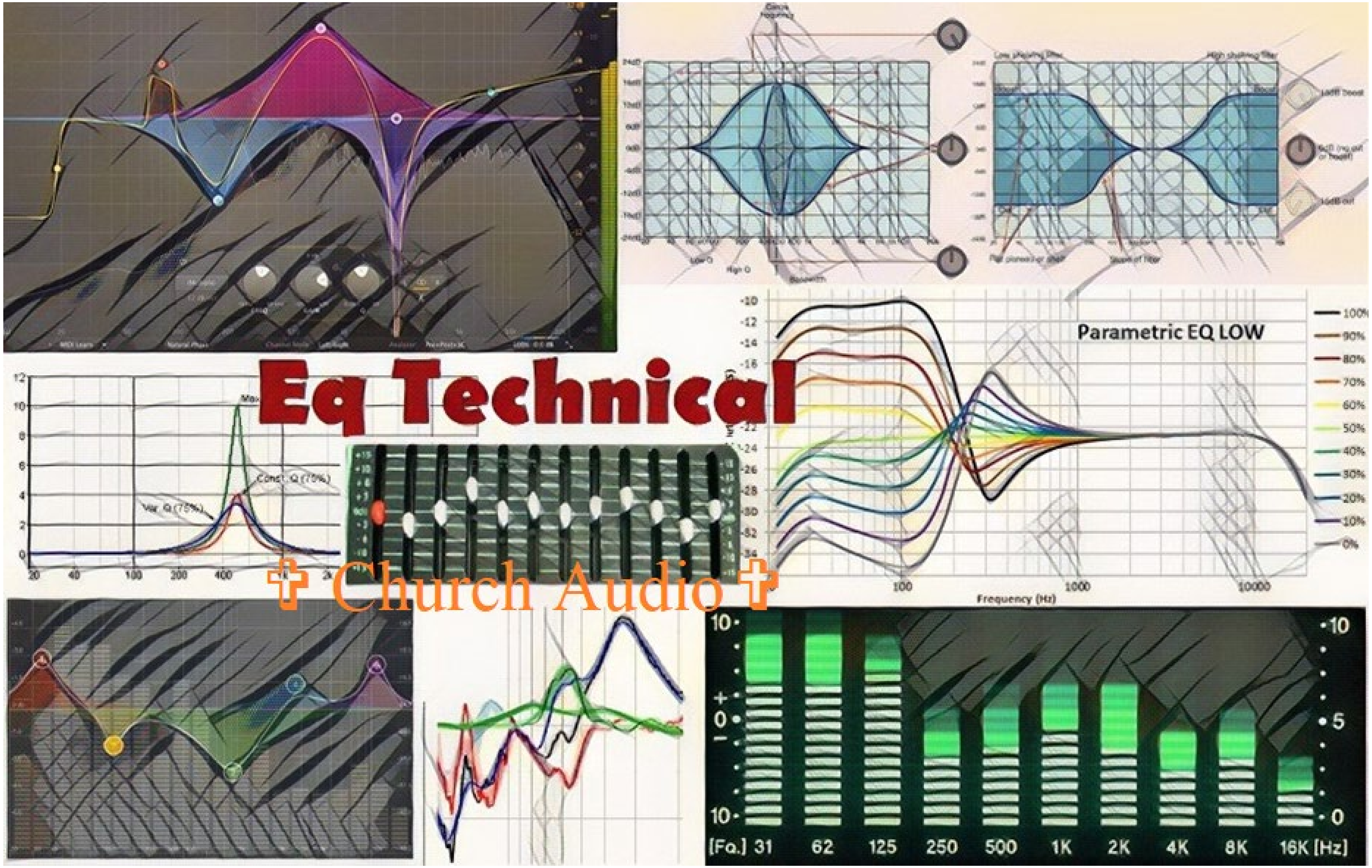
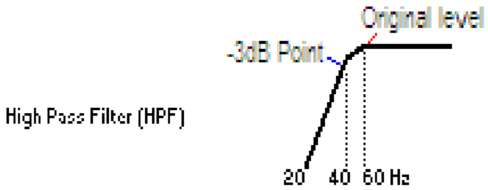

Eq Technical
Church Audio
Parametric EQ LOW
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Frequency (Hz)
100
1000
10000
Const. Q (75%)
Var. Q (75%)
Max
[Fo.] 31 62 125 250 500 1K 2K 4K 8K 16K [Hz]

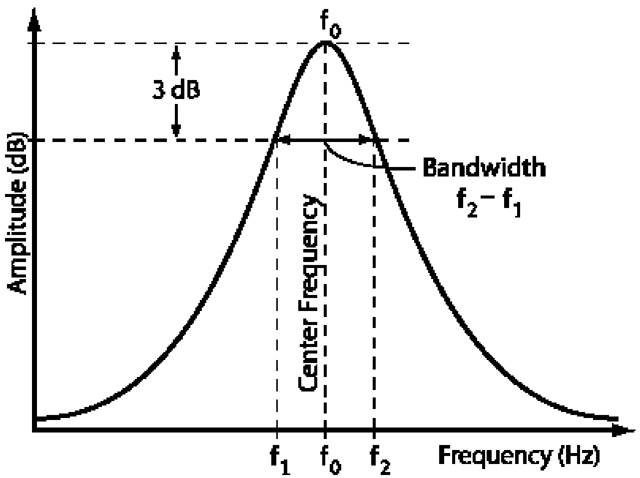
3dB CUT-OFF FREQUENCY

We don't measure the cut-off point of a filter at the beginning of the cut. We look for the point where the frequency has moved 3 dB (the half-power point) from its original value. This is also referred to as the Corner Frequency, or Roll-off Frequency. Some filter types curve differently at the beginning, but beyond the 3dB point all filter-model slopes are constant. 3dB was a point chosen for both electronic and filter-design reasons.



In this diagram we see that the roll-off starts at 60Hz, however we would call this a 40Hz Bass Cut (or High Pass) filter because that is the 3dB point, and the slope is constant from here on.

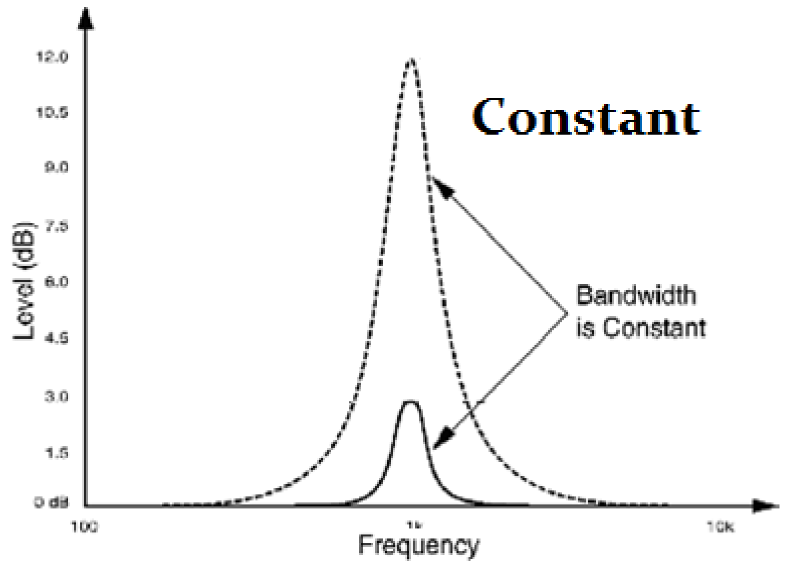
BANDWIDTH

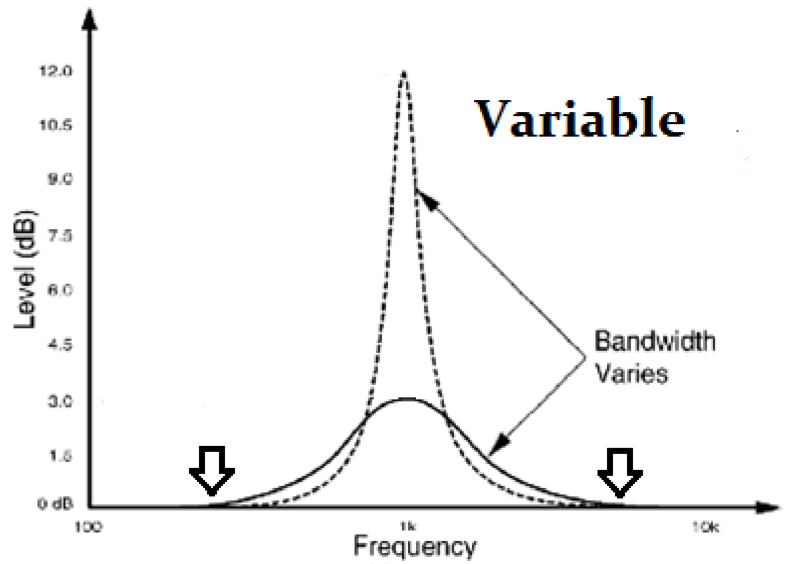


When you select a frequency (Hz) on a Filter, there will be frequencies either side of the *centre frequency* that you selected that will be affected as well. The number of frequencies (the width) either side is called the **Band-width**. We always measure the width of the band at the 3dB point.

Width in Octaves	Width in Q
2.0	0.667
1.0	1.414
2/3	2.145
1/2	2.871
1/3	4.318
1/6	8.651
1/10	14.424
1/30	43.280

Some manufacturers use a musical approach, and measure the width of the *bell curve* in **Octaves**. A *one-octave* filter with a centre frequency of 1kHz will reach from 707Hz up to 1.414kHz (one octave means *double* the frequency in music).
Others measure the width of the *bell curve* in **Q** (Quality factor). One is just the inverse of the other, as you can see in the table above.
Just remember: ***The smaller the Q, the wider the Bandwidth. The greater the Octave, the wider the Bandwidth.***





Equalisers may use one of two kinds of Bandwidth. Each has it's uses. Software Equalisers may allow you to choose, but Mixers usually decide for you. Basically, it means that the bandwidth (how many side frequencies you influence) will be different depending on how much you boost (dB).

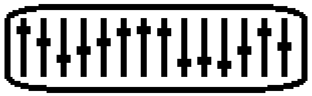
CONSTANT-Q (CONSTANT-BANDWIDTH)

The bandwidth will remain constant for all boost (or cut) levels, so the width of the skirt of the Bell curve will vary **proportionally to boost** (or cut) amounts. Essentially, this means that for small boost/cut levels there will be narrow skirts, and large boost/cut levels will produce wider skirts.

VARIABLE-Q (PROPORTIONAL-Q) (VARIABLE-BANDWIDTH)

The bandwidth will drop **inversely proportional to the boost** (or cut) amount, so the skirts of the Bell curve will remain constant for all boost/cut levels. Essentially, the bandwidth will be very wide for small boost/cut levels, becoming very narrow for large boost/cut levels.

GRAPHIC EQUALISERS



Each Graphic Equaliser Fader has a filter attached to it. The centre frequenciy of each Band-Pass filter is carefully spaced.

Graphic Equaliser	width (Oct)	width (Q)
5 bands	**2 octaves**	**0.7**
7 bands	**1 1/3 octaves**	**1.0**
10 bands	**1 octave**	**1.4**
20 bands	**1/2 octave**	**2.8**
31 bands	**1/3 octave**	**4.2**

Professional Graphic Equalisers use one-third octave spacing which is based on a factor of $2^{1/3}$, which is 1.26-times above (or 0.794-times below) each previous centre frequency.

Following the International Standards Organisation (ISO) standard for 31 bands, the bands are:
20Hz, 25Hz, 31.5Hz, 40Hz, 50Hz, 63Hz, 80Hz, 100Hz, 125Hz 160Hz, 200Hz, 250Hz, 315Hz, 400Hz, 500Hz, 630Hz, 800Hz, 1kHz, 1.25kHz, 1.6kHz, 2kHz, 2.5kHz, 3.15kHz, 4kHz, 5kHz, 6.3kHz, 8kHz, 10kHz, 12.5kHz, 16kHz, 20kHz.

Why do professionals use 1/3-Octave Centres?
1/3-octave represents the smallest region that humans reliably detect a change in sound volume. It relates to auditory *critical bands*.

COMPLIMENTARY EQUALIZATION

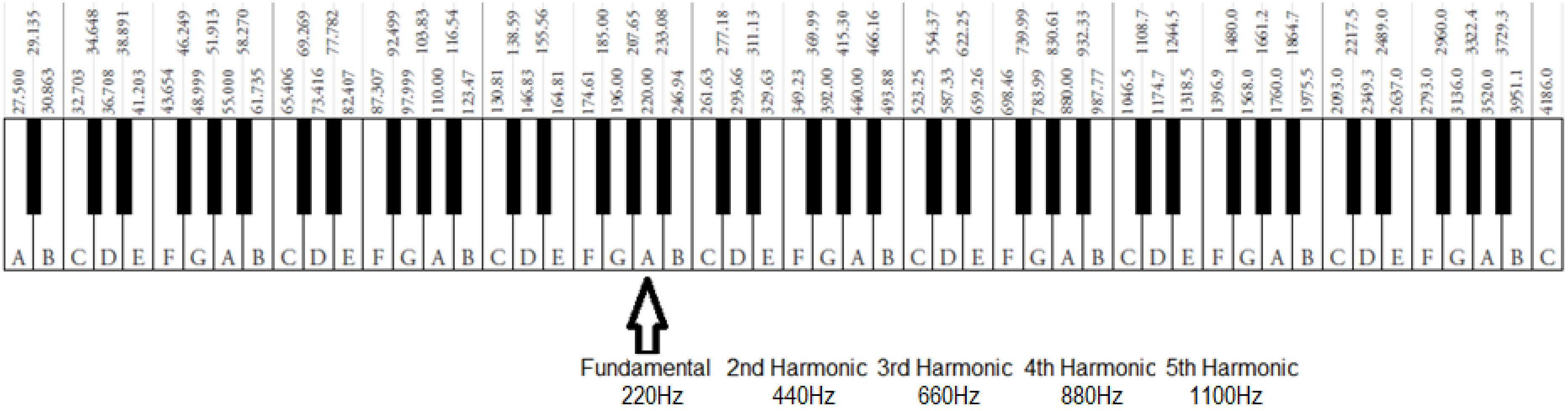
'Masking' happens when one sound confuses another sound because many frequencies in the two sounds are identical. This leaves both of them indistinct and hard to make out in the mix. On their own they sound fine, but playing at the same time they both become hard to hear. One way to remedy this is to use *complimentary equalization*. The idea is to boost a certain frequency band on one instrument and lower that same frequency band on the other instrument. You can do it at several points (boost a zone on one, lower the same zone on the other). This will make both instruments have more "**differences**" in their sounds and they will both become more audible in the mix. It's a great method, you get a lot of sound change with only a little amount (boost/cut 3 dB) of equalisation.

Some typical masking conflicts:

Kick Drum - Bass Guitar
Dip between 350 and 400Hz on the kick drum (helps remove the "cardboard" sound), and increase the same frequency on the bass (adds bass presence).
Lead Vocals - Background Vocals
Dip between 3 and 4 kHz on the background vocals (give them less presence), and increase the same frequency on the lead vocal (making it fresher).
Rhythm Piano - Rhythm Guitar
A Guitar strumming, plus a Piano playing accompaniment, will create a lot of drone (a wall of mid-range sound) and the whole mix will lose any real definition because these two are filling the soundscape with practically every frequency that exists. One remedy is to lower the mid-range of the piano slightly (just keep it's all-important highs and lows). Lower the basses and mid-range slightly on the guitar and boost the high frequencies slightly to get the all-important percussive strumming sound.

REDUCE LEAKAGE/SPILLAGE

With a live drum-kit all of the sounds go into each other's microphones, because they are all so close together, and so loud.
Noise gates are made for this work, but you can improve separation somewhat by filtering away frequency zones you are not using.
Remove cymbals from a kick drum set a Shelf filter to cut above 5kHz.
Remove kick drum from cymbals set a Shelf filter to cut below 500Hz.



Firstly, keep in mind… a musical note is just a single frequency.
When you play a note (example note 'A' or 220Hz, same thing), we call this the **Fundamental** note (fundamental frequency).
A single frequency (in our case 220Hz) only lasts for milliseconds (a law of nature) then the materials around it will ripple off mathematical multiplications (Harmonics) (Overtones) of our frequency. These harmonic frequencies mix in with our original pure note.

The note started life as a single 220Hz, but almost instantly a 2^{nd} harmonic split off (440Hz), then it tripled (3^{rd} Harmonic) 660Hz, then quadrupled (4^{th} Harmonic) 880Hz, then quintupled (5^{th} Harmonic) 1100Hz etc. etc. etc. splitting till it runs out of energy.
All of these extra harmonic frequencies mix in with the original note at different volumes, giving our note 'A' a harmonious colour. It depends what the instrument is made of… wood will generate a certain mixture of harmonics, brass will generate a different mixture. This is how you can hear the same note (A or 220Hz) but by the extra colours wrapped around the note you realise what kind of instrument it was played on.

If you have access to a spectrum analyser while you are working, look where the lowest (fundamental) notes are, or if you know the tuning of the instrument then you will know the frequency zone of the fundamentals, then take advantage of this knowledge…
If you boost the Fundamental, you will give the sound a strong sense of musical pitch (musical note).
If you boost the 2nd Harmonic, you will reinforce the note, giving it strength.
If you boost the 3rd Harmonic, you will lower the volume.
If you boost the 4th Harmonic, you will add a sense of fullness.
If you boost the 5th Harmonic, you will give the sound 'bite' and 'edge'.

CREDITS

This material is offered freely to the Christian Churches; downloadable at Pietango.com

Text: *Original, by the Author, a Christian Recording Engineer.*
Images: *Designed by the Author. Some photographs were sourced from the Internet, then re-worked.*

Ever since the creation of the world, God's invisible attributes and divine nature have been evident. They are clearly understood through his workmanship, and all the wonderful things that he has made. Therefore, those who fail to believe and trust in him are without excuse, or defence. **Romans 1:20**

All of us have sinned and fallen short of God's glory, but God treats us much better than we deserve.
Because of Christ Jesus, he freely accepts us and sets us free from our sins. God sent Christ to be our sacrifice. Christ offered his life's blood, so that by faith in him we could come to God. **Romans 3:23**

If you declare with your mouth, "Jesus is lord," and believe in your heart that God raised him from the dead, you will be saved. For it is with your heart that you believe and are justified, and it is with your mouth that you profess your faith and are saved. **Romans 10:9**

For the Scripture (*Isaiah 28:16*) says, "Whoever believes in Him will not be disappointed." **Romans 10:11**

These things have been written so that you may believe that Jesus is the Christ, the son of God; and that by believing, and relying on him, you may have new life in his name. **John 20:31**