

Illustrative photo: a capacitor bank cubicle with detuning reactors below.

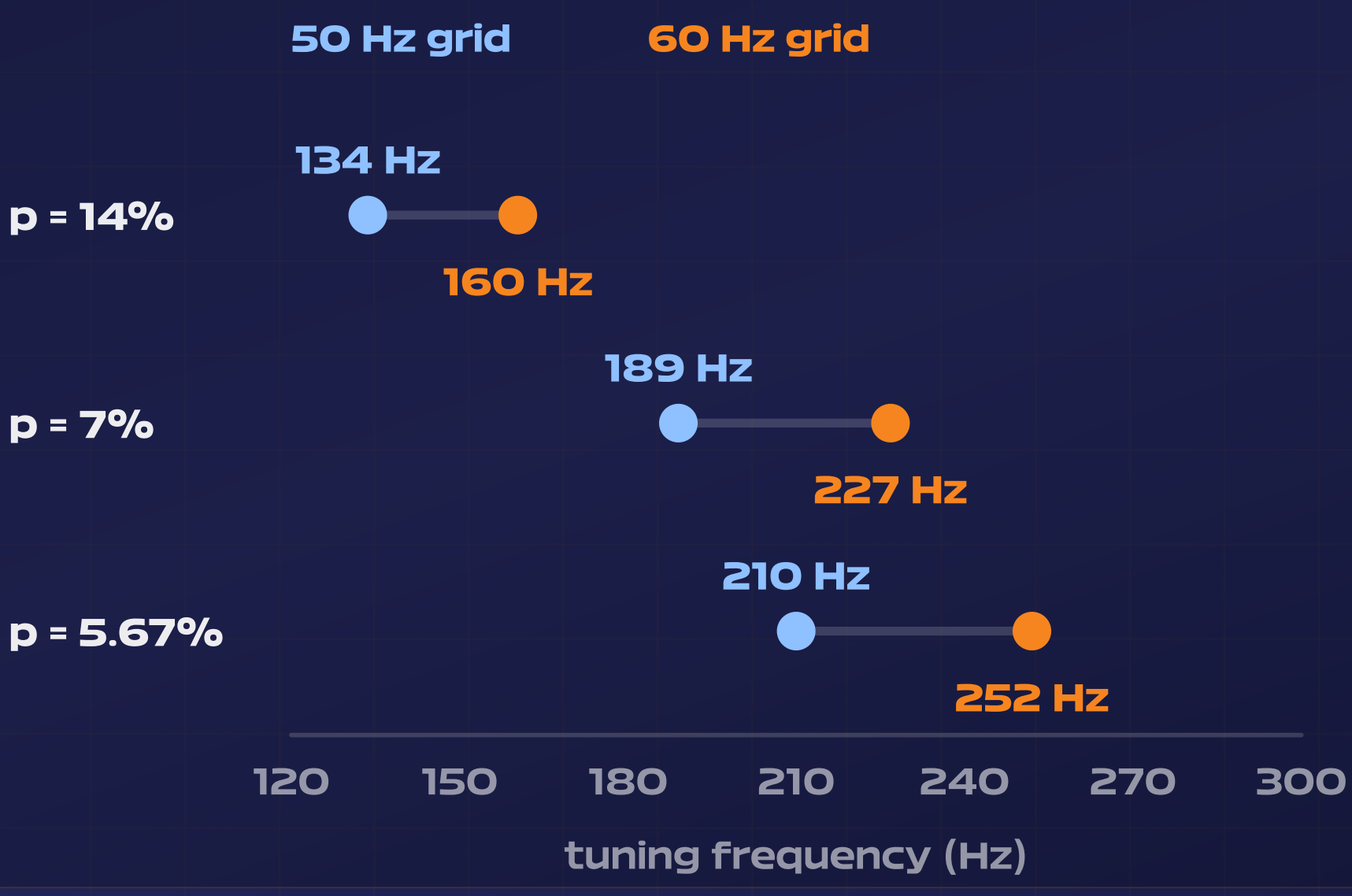
NLC ACADEMY · EPISODE 37

Detuned reactors, check the table.

CIRCUTOR lists p = 14% at 134 Hz on a 50 Hz grid for some installations, not 189 Hz. On a 60 Hz grid the same factor tunes to 160 Hz (calculated).

THE SAME FACTOR

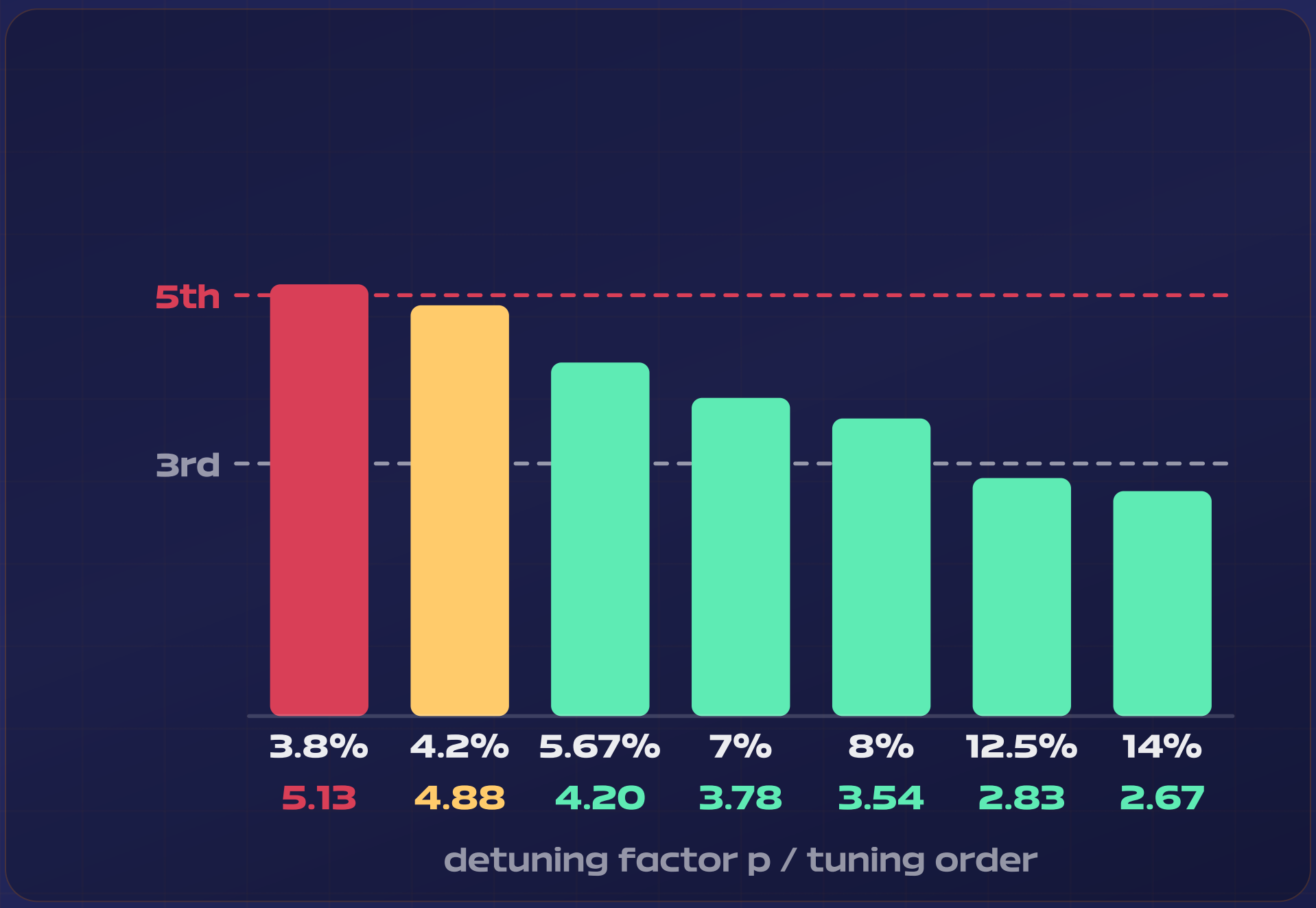
Same factor, different frequency



Calculation: the tuning order n = 1/√p stays fixed. The tuning frequency f = f1/√p moves with the grid, 50 Hz or 60 Hz.

TUNING ORDER

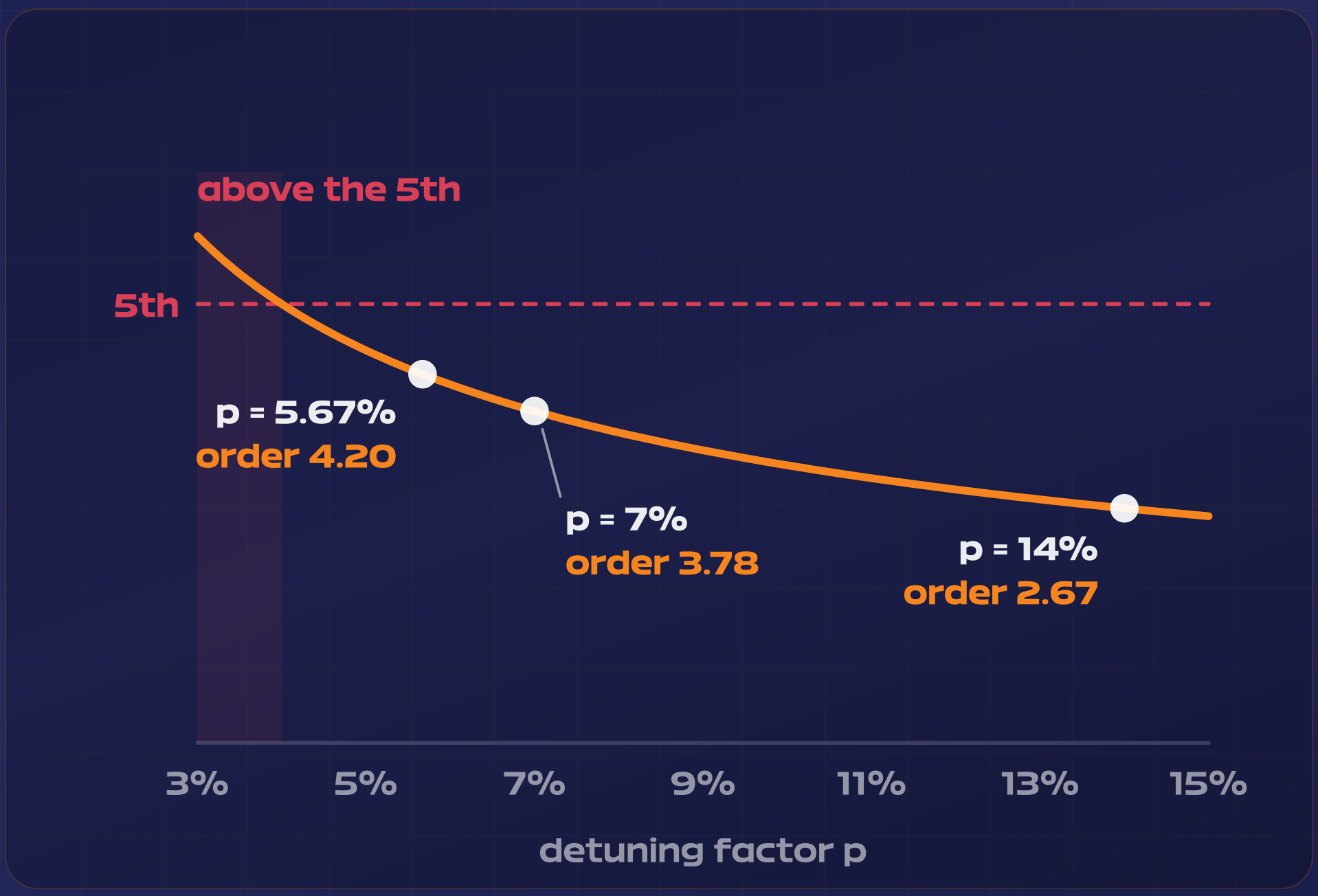
3.8% tunes above the 5th. 4.2% sits just under it.



Calculated with n = 1/√p, the same on 50 Hz and 60 Hz grids: p = 7% and p = 14% tune well below the 5th, at orders 3.78 and 2.67.

THE ORDER RULE

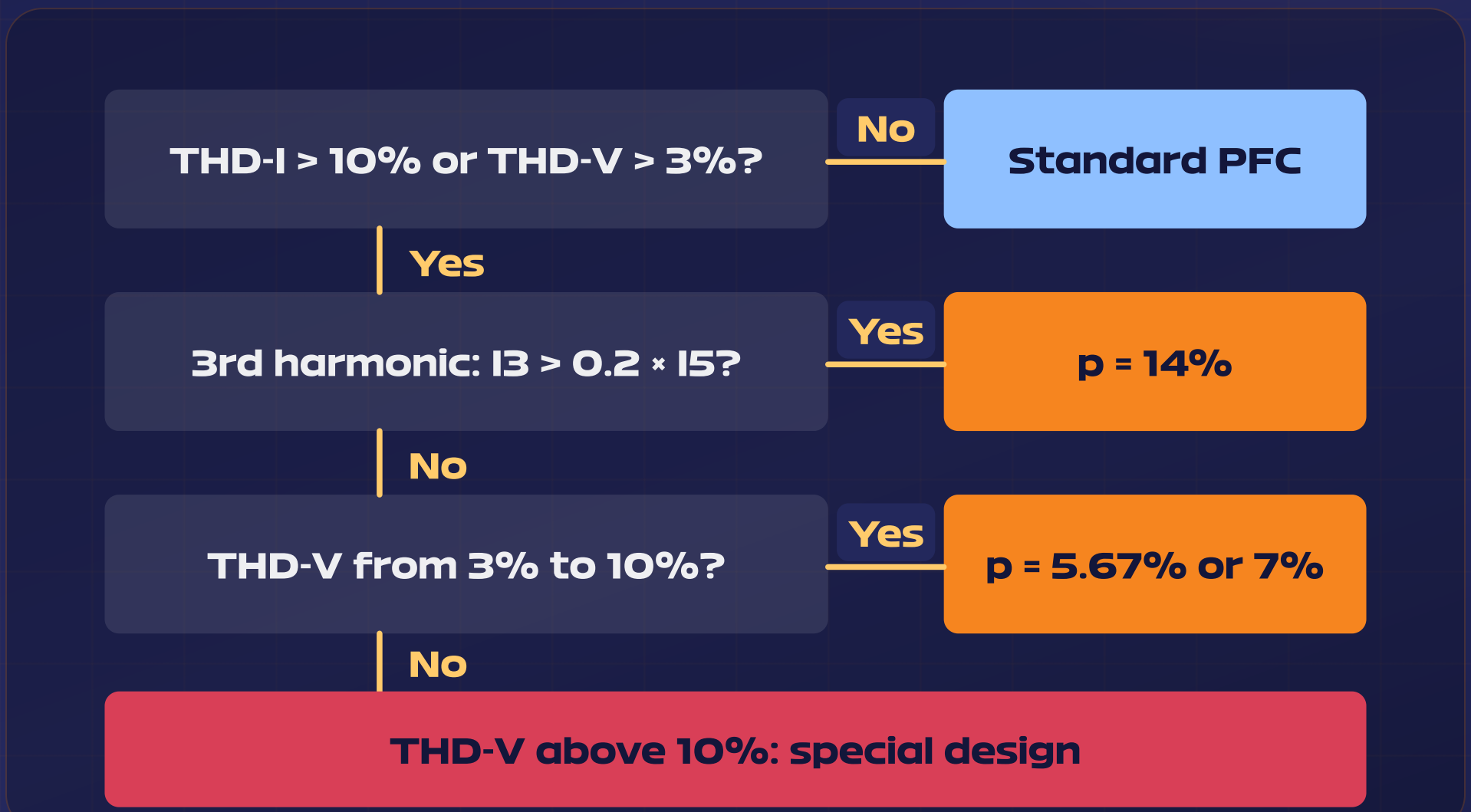
Below 4%, the factor tunes above the 5th



Calculation: tuning order n = 1/√p is a multiple of f1 and depends on p alone, so it is the same on 50 Hz and 60 Hz grids.

CHOOSING p

EPCOS guidance: a strong 3rd harmonic can point to 14%



Manufacturer design guidance (EPCOS, 2009), not a standard requirement: p = 14% when I3 is above 0.2 × I5, otherwise 5.67% or 7%, depending on THD-V.

Final reactor selection depends on the network frequency (60 Hz in Saudi Arabia [4]), the harmonic spectrum, system impedance, resonance conditions, capacitor and reactor ratings, and the manufacturer's specification.

CAPACITOR RATING

Rate the capacitor above the supply voltage



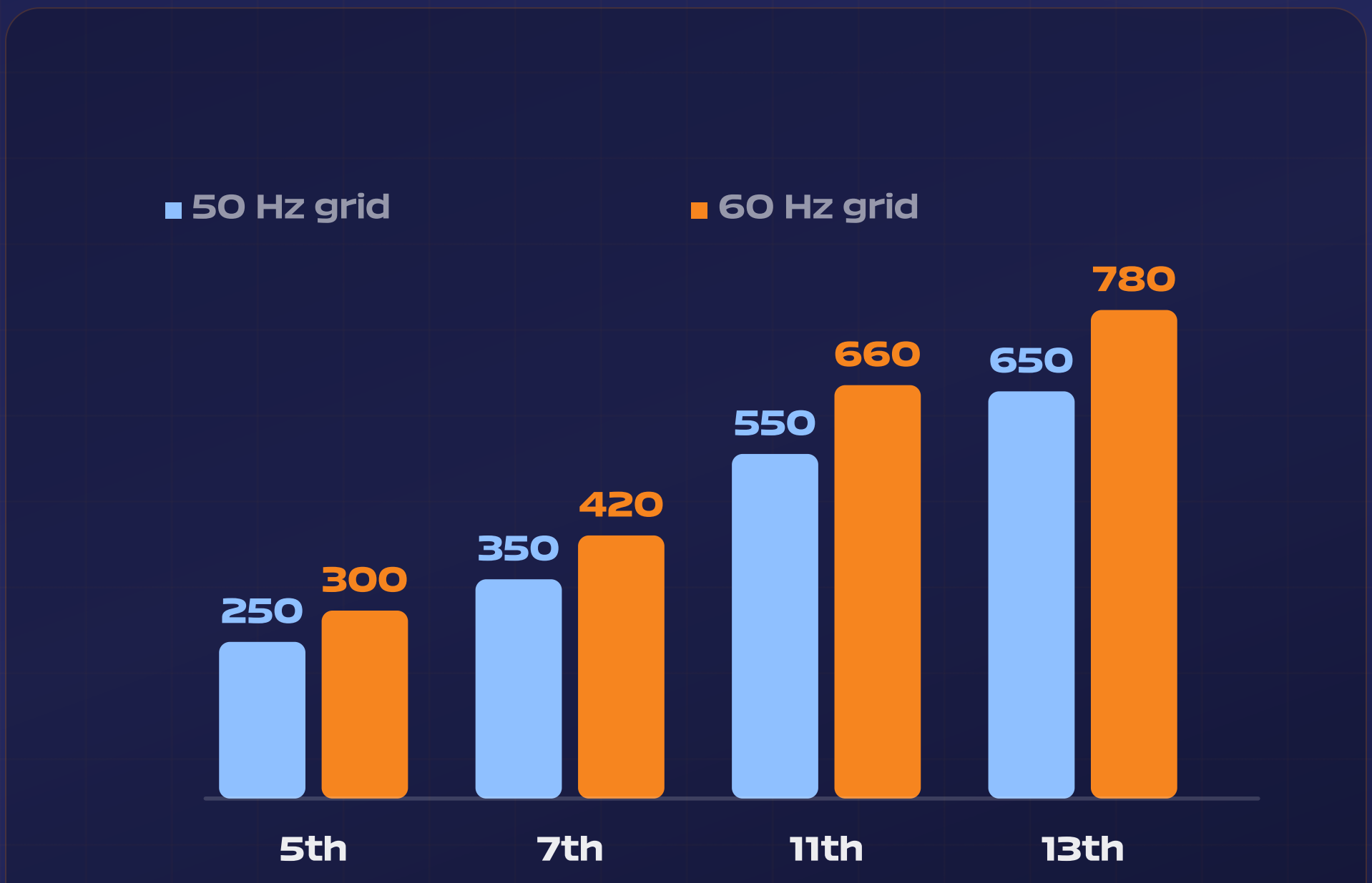
factor = rated kvar ÷ required kvar per step

Vishay (manufacturer data): for filter circuits the rated voltage of the capacitor has to be higher than the supply voltage.

Vishay table example (manufacturer data): 50 kvar per step, 400 V, 7%, 440 V capacitor: 50 × 1.125 = 56.25 kvar rated.

SURVEY FIRST

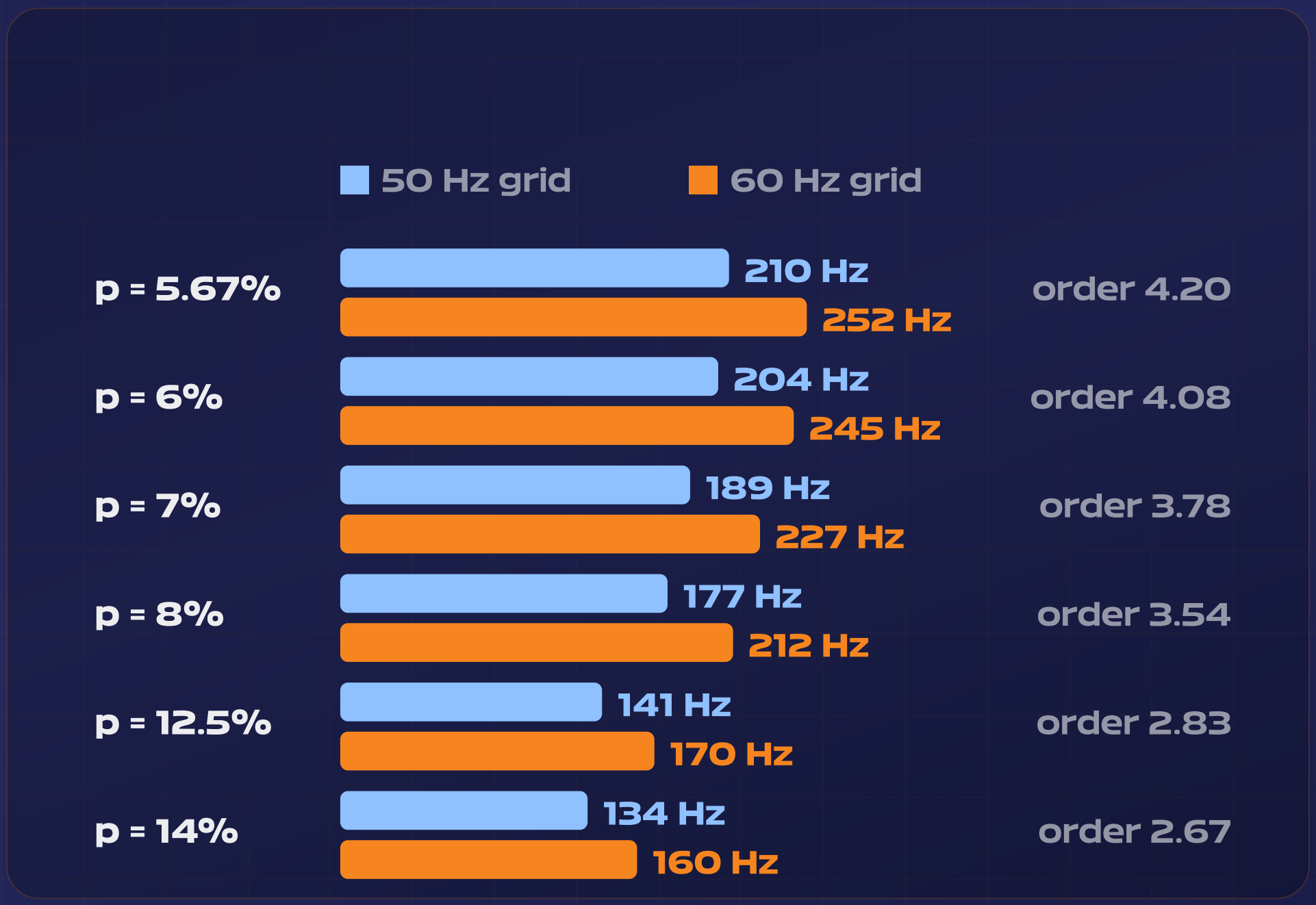
On a 60 Hz grid the 5th is 300 Hz, not 250 Hz



An analyser set to 50 Hz reads a 300 Hz component as the 6th, not the 5th.

REFERENCE TABLE

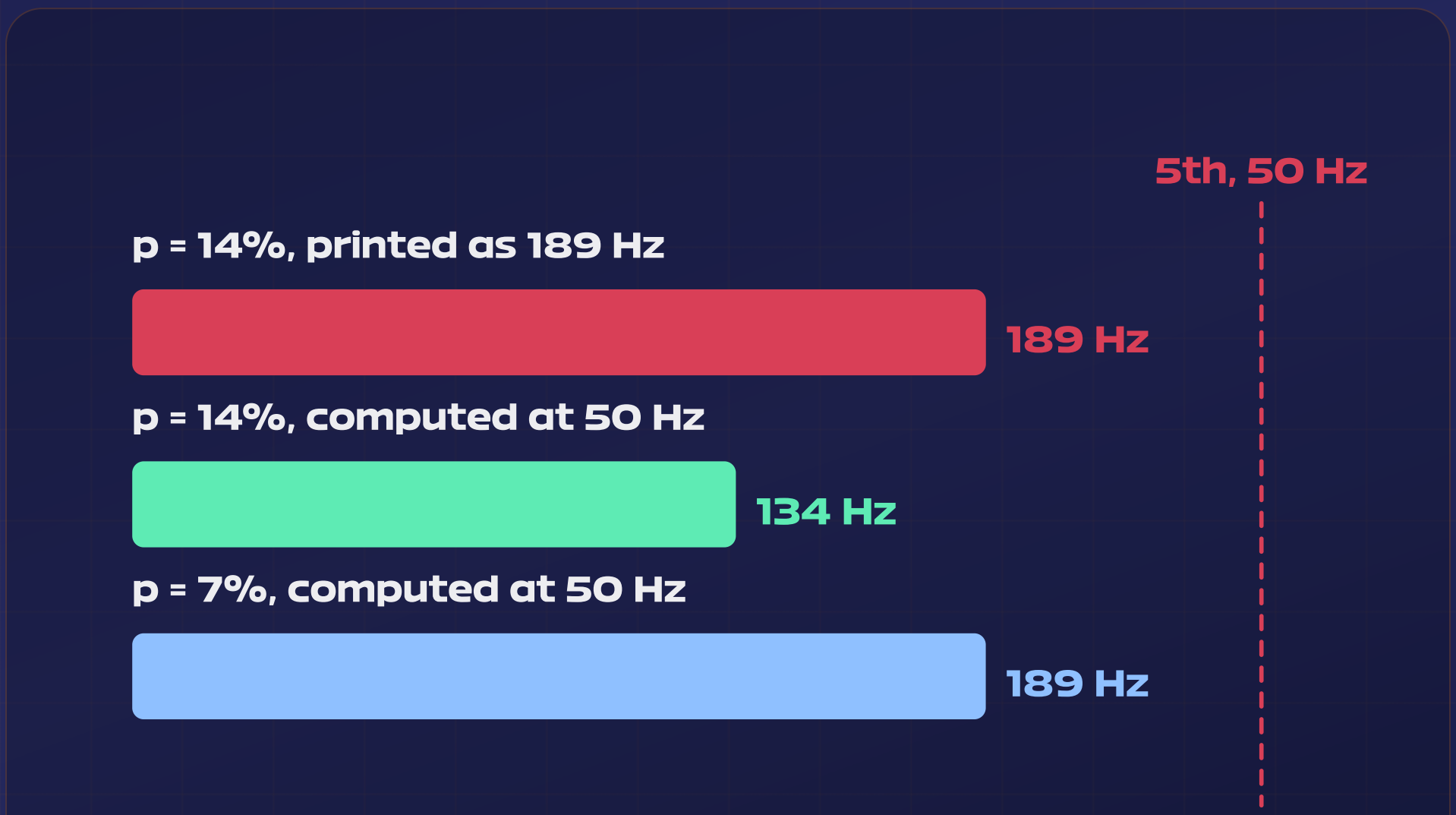
Detuning factor at 50 Hz and 60 Hz



Calculated: f = f1/√p and n = 1/√p for every row. Manufacturer data: CIRCUTOR prints 189 Hz (7%) and, for some installations, 134 Hz (14%), both for 50 Hz grids.

THE MISTAKE

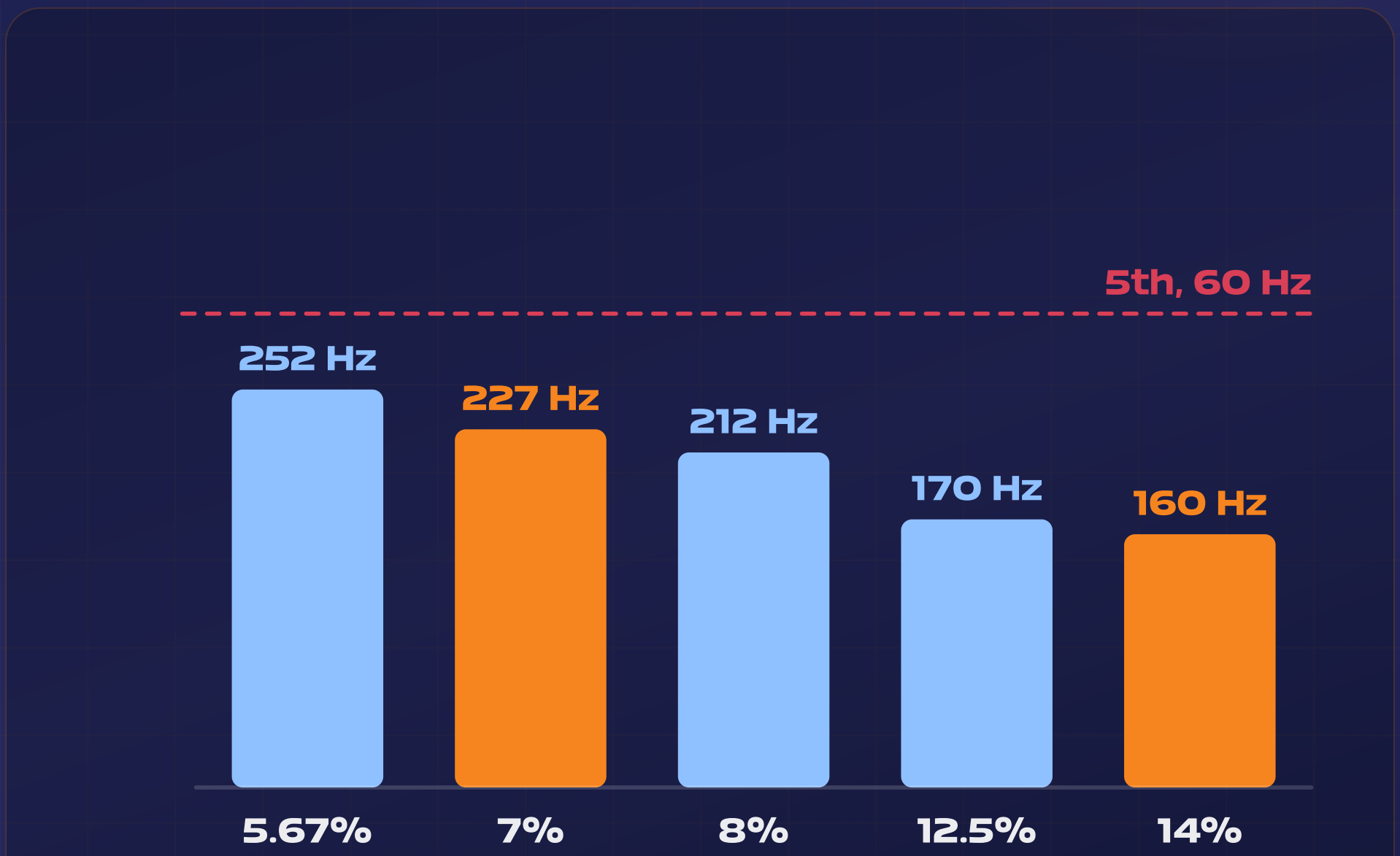
On a 50 Hz grid, 189 Hz is p = 7%, not p = 14%



A table that pairs 14% with 189 Hz gets the frequency wrong: 14% gives 134 Hz on a 50 Hz grid (calculated). Both tune below the 5th, 250 Hz.

THE CORRECTION

At 60 Hz: 7% tunes to 227 Hz, 14% to 160 Hz

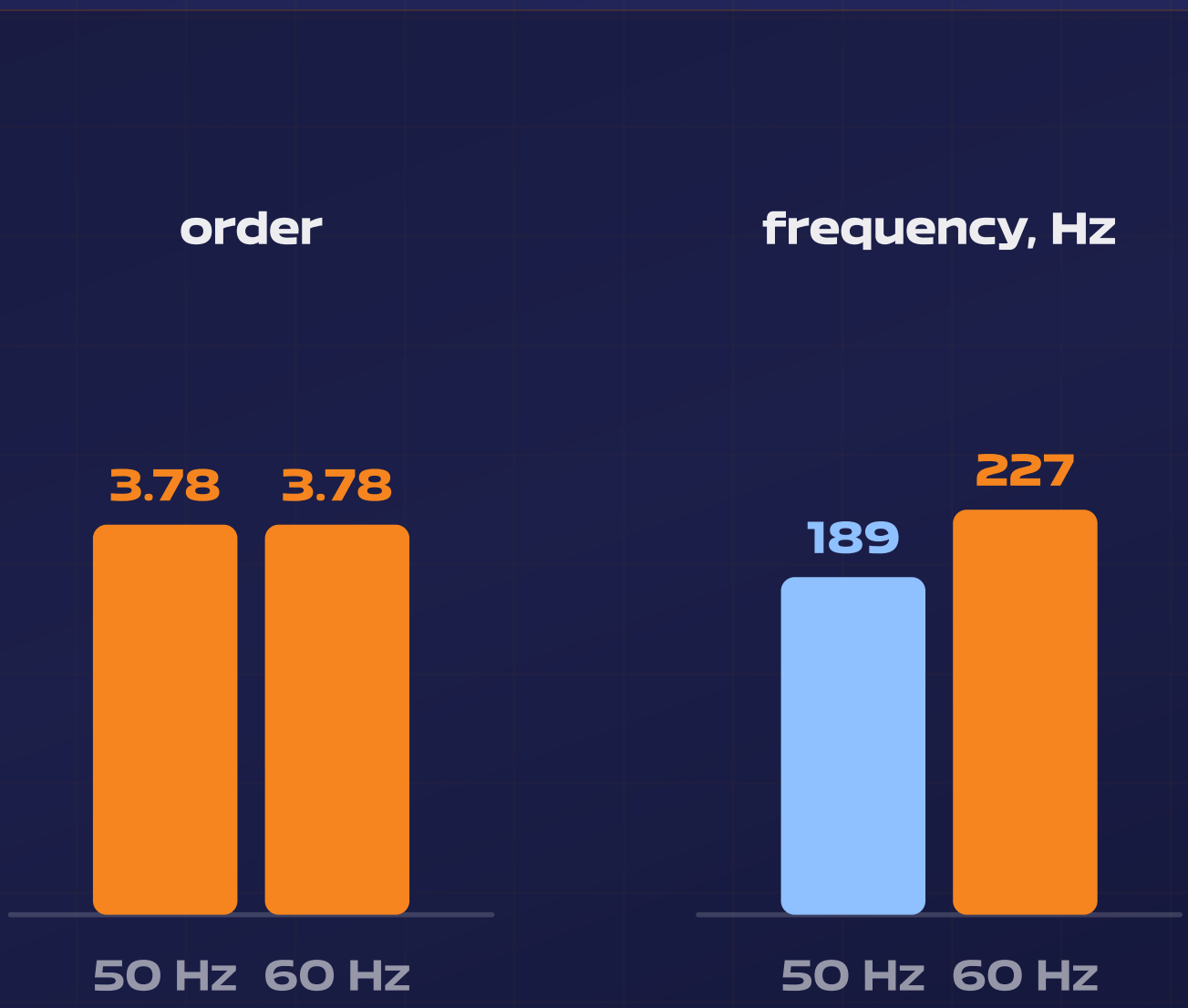


Manufacturer data: CIRCUTOR offers 227 Hz for 60 Hz networks on demand. Ask for it by name on the quote.

160 Hz is calculated from f1/√p at 60 Hz. CIRCUTOR's published 60 Hz value, for 7% only, is 227 Hz.

THREE NUMBERS

The order holds. The frequency moves with the grid.



Calculated, p = 7%: order 3.78 on both grids, 189 Hz on a 50 Hz grid and 227 Hz on a 60 Hz grid.

ON SITE

Check every switching state, not only the full bank



Illustrative photo: a capacitor bank with detuning reactors below.

Each state
step in or out
resonance can form with the supply

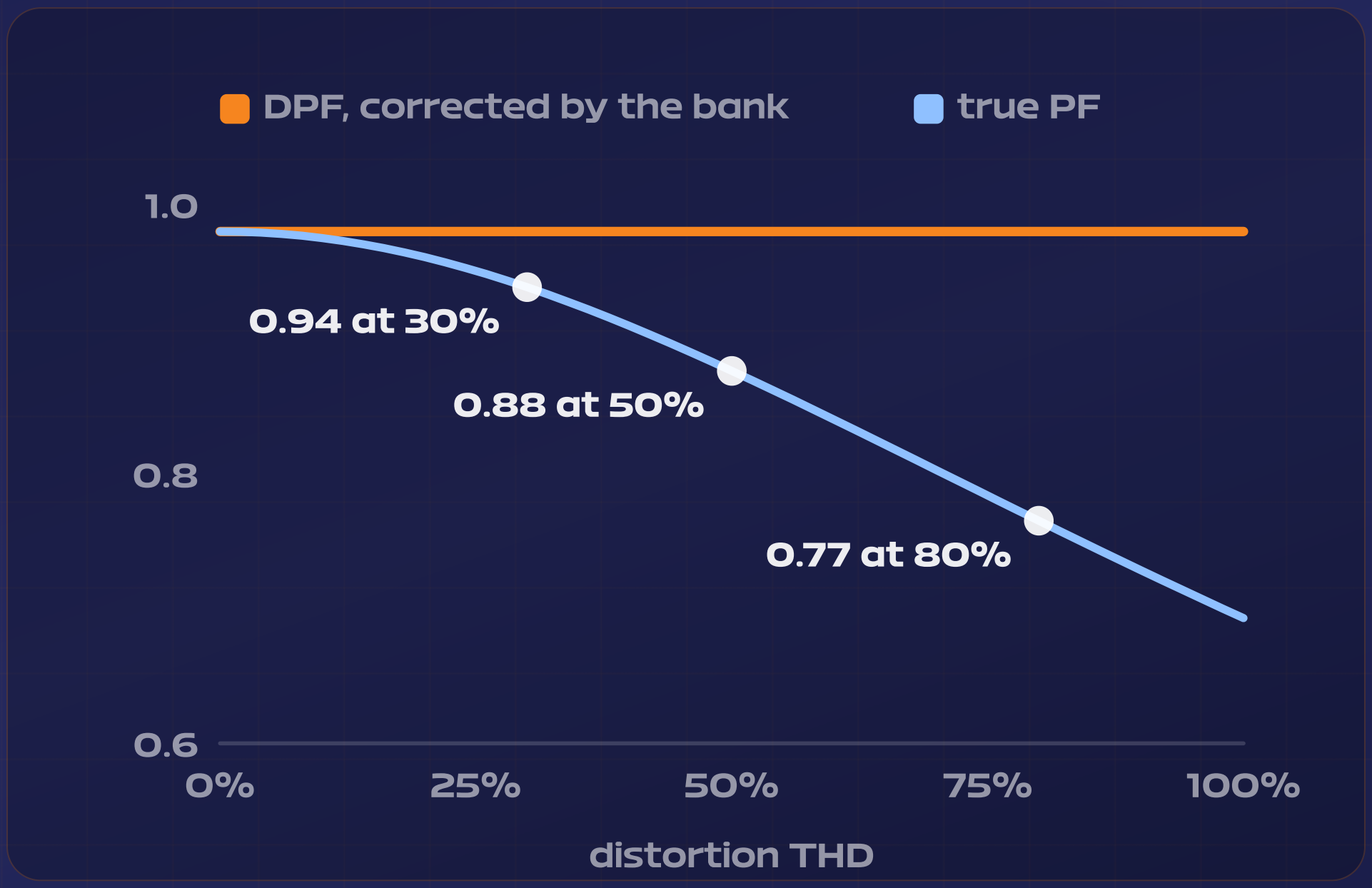
Survey
THD-I and THD-V
before choosing p

Quote
frequency and p
name 50 Hz or 60 Hz

EPCOS (manufacturer) guidance: capacitors without reactors can resonate with the line inductance, mainly the input transformer.

POWER FACTOR

The bank corrects displacement, not distortion

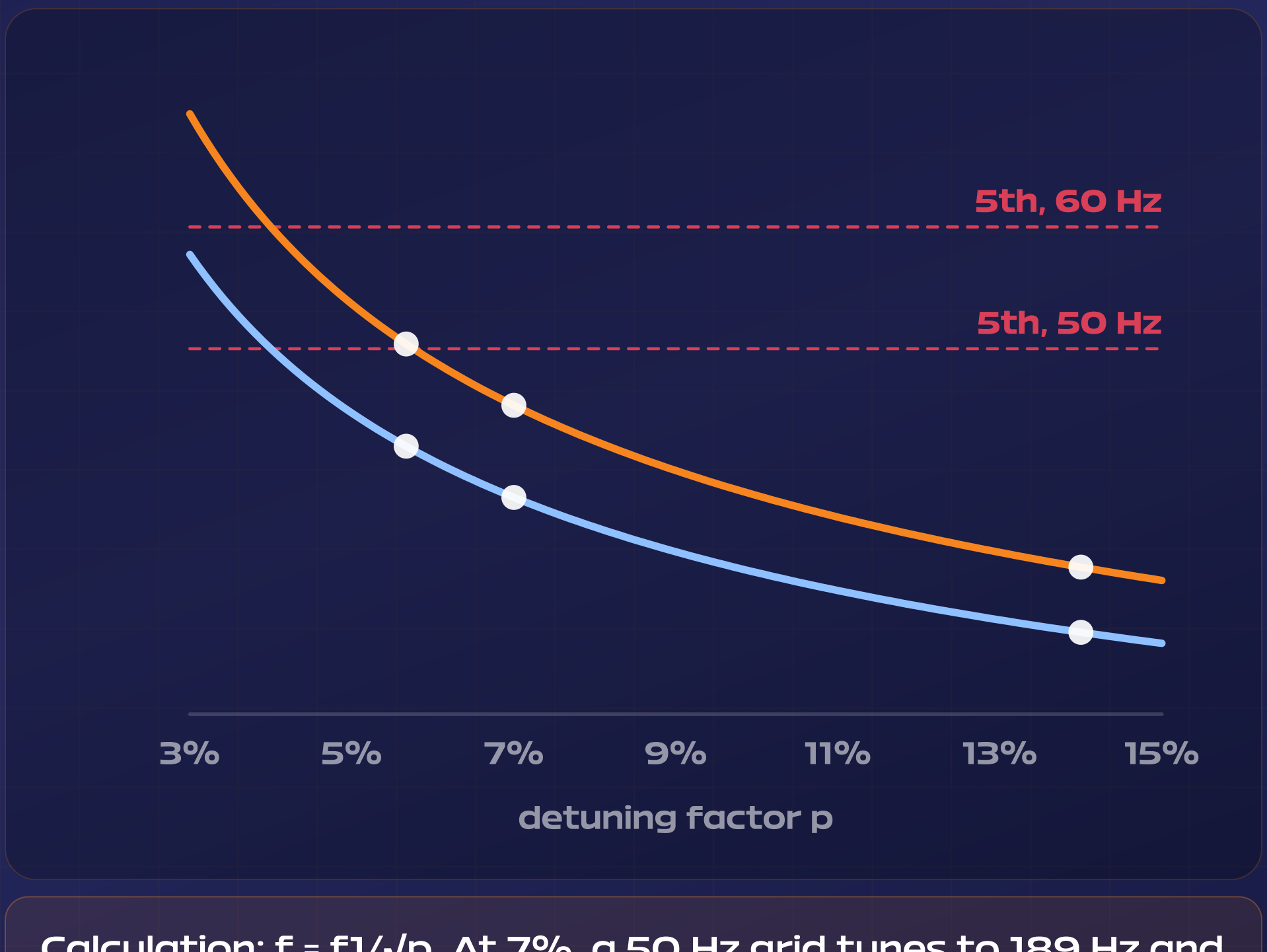


At 50% distortion, true PF is 0.88 if the bank holds displacement at 0.98.

True PF = DPF / $\sqrt{(1 + THD_I^2)}$, from the THD-I definition (EPCOS, p. 7). Sinusoidal voltage assumed. Calculation, not a catalogue value.

THE FREQUENCY RULE

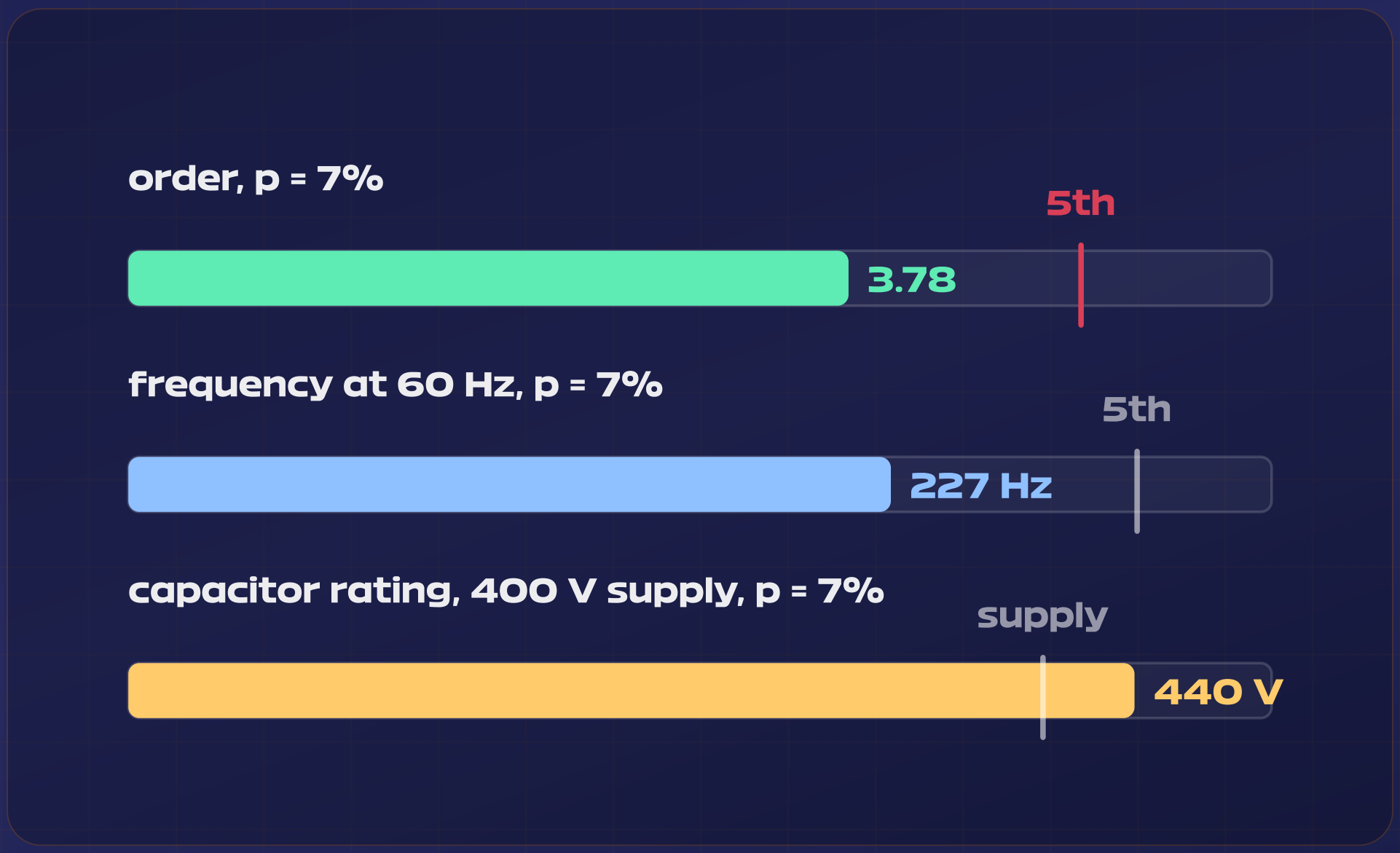
Same factor, higher frequency on 60 Hz



Calculation: f = f1/√p. At 7%, a 50 Hz grid tunes to 189 Hz and a 60 Hz grid to 227 Hz.

BEFORE YOU SIGN

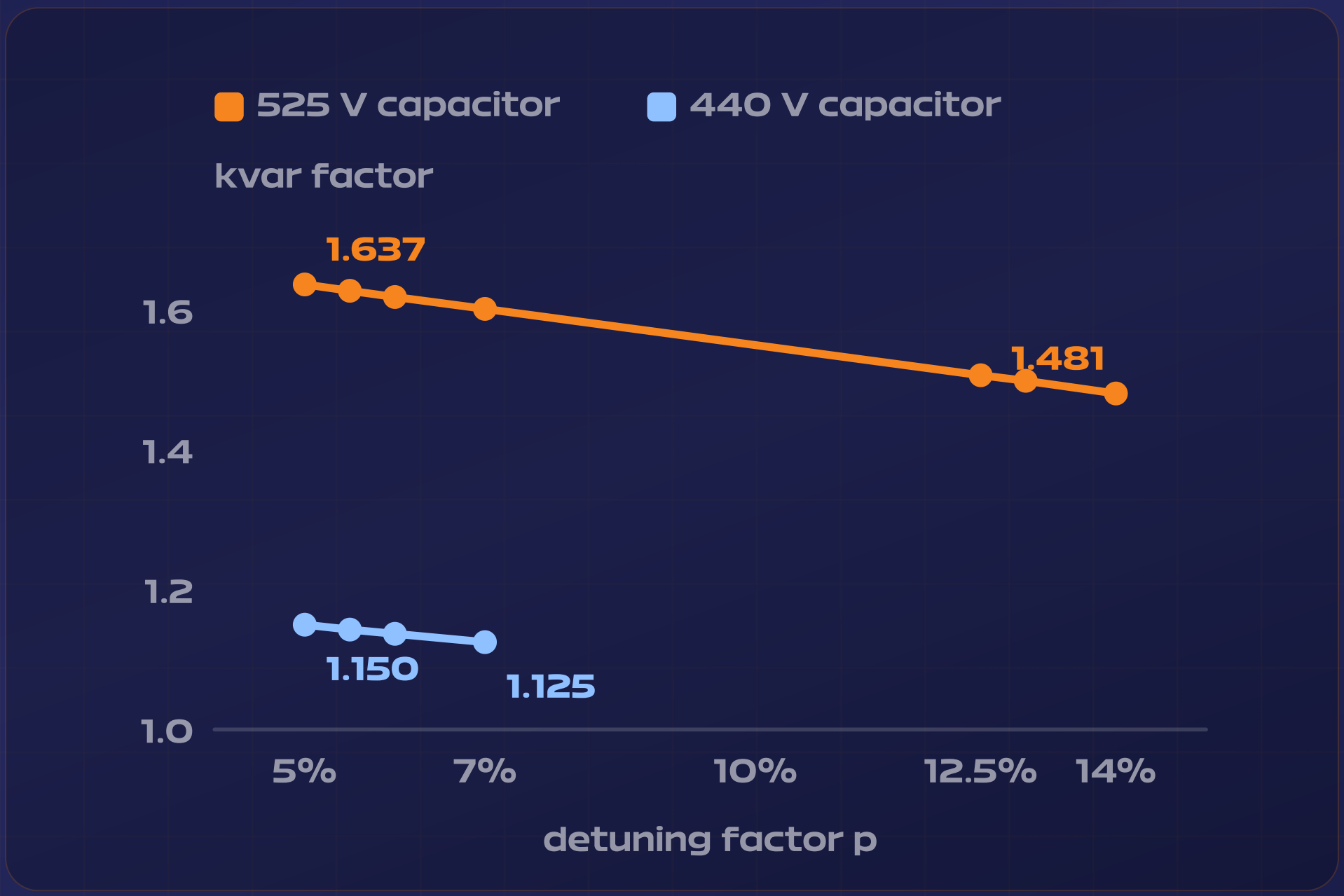
Three numbers to check against the quote



1. Ask which grid frequency the tuning was calculated for: 50 Hz, or 60 Hz in Saudi Arabia.
2. Ask for the capacitor rated voltage, and compare it with the supply voltage.

READ THE TABLE

The factor depends on the rating and on p



1. Read the factor for your supply voltage, rating and p from the manufacturer's table (here Vishay).
2. Vishay's 415 V table has no 440 V value at 7%, so a 440 V capacitor is not in that row.

SOURCES

Where the numbers come from



[1] CIRCUTOR, Reactors III, RBZ-25-400, product page P73130
[2] EPCOS (TDK), Design Rules for PFC Systems, ANo 116/V1, 2009
[3] Vishay, Detuned filter capacitor output, doc 13186 (2017)
[4] SEC Grid Code, May 2026, cl. 2.10.2.1, 60 Hz nominal
[5] f = f1/sqrt(p) and n = 1/sqrt(p), NLC calculation
[6] PF = DPF/sqrt(1+THD_I^2), from the THD-I definition in [2]

Calculations [5]: frequencies and orders, matching CIRCUTOR's 50 Hz values. Manufacturer data [1] to [3]: 5.67%, 7% and 14% in EPCOS, 7% and 14% in CIRCUTOR. Grid code [4]: 60 Hz nominal. Other factors are calculated examples.

Practical electrical engineering

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https://nlc.com.sa/academy/capacitor-banks-detuning.html

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