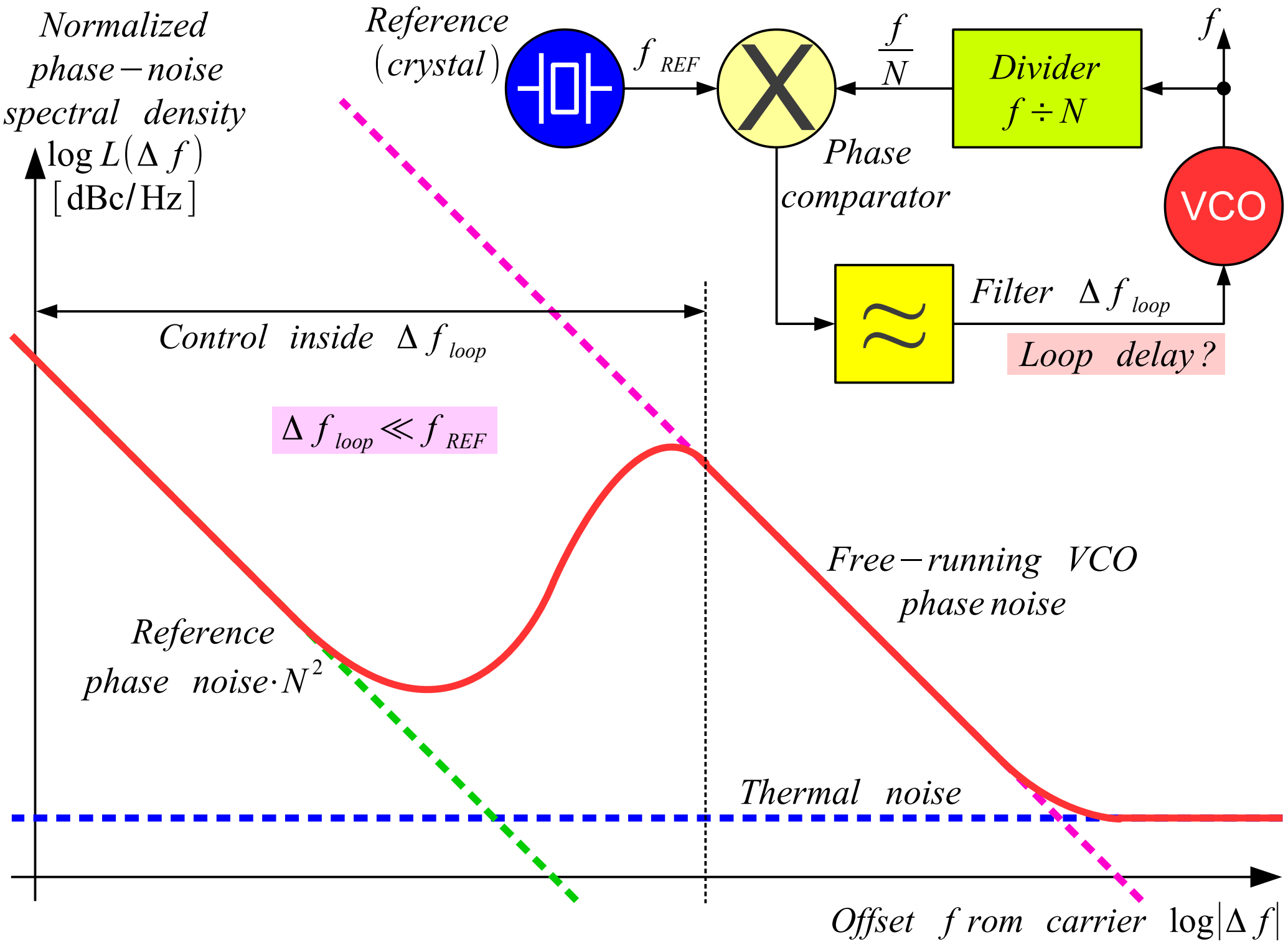
Normalized phase−noise spectral density
log L(Δ f)
[dBc/Hz]
Reference (crystal)
f REF
f/N
Divider f ÷ N
f
Phase comparator
VCO
Filter Δ f loop
Loop delay?
Control inside Δ f loop
Δ f loop ≪ f REF
Free−running VCO phase noise
Reference phase noise·N²
Thermal noise
Offset from carrier log|Δ f|