Theoretical calculation of idealized planar FAIMS Delta Y per RF cycle. djm200906

$DV := 750$ V $\qquad period := 2 \cdot 10^{-6}$ sec

First for square wave: high (h) and low (l) parts

$duty := 0.25$

$Vh := DV \quad Vl := -DV \cdot \frac{duty}{1 - duty} \qquad Vh = 750 \quad Vl = -250$ V $\qquad d := 0.5 \cdot 10^{-3}$ m

$Eh := \frac{-Vh}{d} \qquad El := \frac{-Vl}{d}$ V/m

$N := 2.4614900929932 \cdot 10^{25}$ n/m^3 (calculated by SDS code)

$alpha := 10 \cdot 10^{-6}$ TD^-2 = 10^42 V^-2 m^-4

$beta := 0$ TD^-4 = 10^84 V^-4 m^-8

$k0 := 2.17$ 10^-4 m^2 V^-1 s^-1

$p\_stp := 760$ Torr $\quad T\_stp := 273.15$ K $\quad$ standard conditions k0 was measured at

$p := 760$ Torr $\quad T := 298.15$ K

$$ratioh := 1 + \frac{alpha}{10^{-42}} \cdot \left(\frac{Eh}{N}\right)^2 + \frac{beta}{10^{-84}} \cdot \left(\frac{Eh}{N}\right)^4 \qquad ratiol := 1 + \frac{alpha}{10^{-42}} \cdot \left(\frac{El}{N}\right)^2 + \frac{beta}{10^{-84}} \cdot \left(\frac{El}{N}\right)^4$$

$$kh := k0 \cdot \left(\frac{p\_stp}{p}\right) \cdot \left(\frac{T}{T\_stp}\right) \cdot ratioh$$ 10^-4 m^2 V^-1 s^-1 $$kl := k0 \cdot \left(\frac{p\_stp}{p}\right) \cdot \left(\frac{T}{T\_stp}\right) \cdot ratiol$$

$ratioh = 1.037 \quad ratiol = 1.004 \quad kh = 2.457 \quad kl = 2.378$

$th := period \cdot duty \qquad tl := period \cdot (1 - duty)$

$$deltaY := Eh \cdot \frac{kh}{10^4} \cdot th + El \cdot \frac{kl}{10^4} \cdot tl$$ m $\qquad deltaY \cdot 10^3 = -0.0058639$ mm

Now for arbitrary waveform (e.g. bisinusoidal)

$W := \frac{2 \cdot \pi}{period} \qquad h := 2 \quad F := 2$

$$V(t) := (F \cdot \sin(W \cdot t) + \sin(h \cdot W \cdot t - 0.5 \cdot \pi)) \cdot \frac{DV}{F + 1} \qquad E(t) := \frac{-V(t)}{d}$$

$$ratio(t) := 1 + \frac{alpha}{10^{-42}} \cdot \left(\frac{E(t)}{N}\right)^2 + \frac{beta}{10^{-84}} \cdot \left(\frac{E(t)}{N}\right)^4$$

$$k(t) := k0 \cdot \left(\frac{p\_stp}{p}\right) \cdot \left(\frac{T}{T\_stp}\right) \cdot ratio(t)$$

$$deltaY := \int_0^{period} E(t) \cdot \frac{k(t)}{10^4} \, dt$$ $\qquad deltaY \cdot 10^3 = -0.00293$ mm