Note also that the purely real longitudinal ***specific*** acoustic impedance $z_a^{\|}(x) = \rho_o c \equiv z_o \ (\Omega_a)$ and/or the longitudinal ***specific*** acoustic admittance $y_a^{\|}(x) = 1/z_a^{\|}(x) = 1/\rho_o c \equiv y_o^{\|} = 1/z_o^{\|} \ (\Omega_a^{-1})$ and also the longitudinal velocity of energy flow, $\tilde{c}_a^{\|}(x) = c$ associated with a 1-D monochromatic plane wave propagating *e.g.* in the +*x*-direction in "***free air***" have ***no*** spatial (*i.e.* *x*-) and/or frequency (*i.e.* *f* -) dependence.

The ***instantaneous time-domain*** longitudinal acoustic intensity associated with a 1-D monochromatic plane traveling wave propagating in the +*x*-direction in "***free air***" is also a ***purely real*** quantity – *i.e.* plane wave acoustic energy is entirely in the form of ***pure sound radiation*** – no acoustic energy is {temporarily} stored "locally" at the point *x*. The ***instantaneous time-domain*** complex longitudinal acoustic intensity is:

$$I_a^{\|}(x,t) \equiv p(x,t)\cdot u^{\|}(x,t) = p_o u_o^{\|} \cos^2(\omega t - kx)$$

For an observer's/listener's position *e.g.* at $x = 0$:

$$I_a^{\|}(x=0,t) = p(x=0,t)u^{\|}(x=0,t) = p_o u_o^{\|} \cos^2 \omega t$$

Noting that the time-averaged $\left\langle \cos^2 \omega t \right\rangle_t \equiv \frac{1}{\tau}\int_{t=0}^{t=\tau} \cos^2 \omega t \, dt = \frac{1}{2}$, the ***time-averaged instantaneous time-domain*** complex longitudinal sound intensity at the listener's position $x = 0$ associated with a 1-D monochromatic plane traveling wave propagating in the +*x*-direction in "***free air***" is:

$$\left\langle I_a^{\|}(x=0,t) \right\rangle_t = p_o u_o^{\|} \left\langle \cos^2 \omega t \right\rangle_t = \tfrac{1}{2} p_o u_o^{\|}$$

We can also define ***RMS amplitudes*** of over-pressure and particle velocity in terms of their respective ***peak amplitudes***: $p_o^{rms} \equiv \frac{1}{\sqrt{2}} p_o$ and $u_o^{\| rms} \equiv \frac{1}{\sqrt{2}} u_o^{\|}$. Thus, we see that the ***RMS*** value of the ***instantaneous time-domain*** longitudinal sound intensity at the listener's position $x = 0$ associated with a 1-D monochromatic plane traveling wave propagating in the +*x*-direction in "***free air***" is equal to the ***time-averaged*** longitudinal sound intensity at that point, *i.e.*:

$$I_a^{\| rms}(x=0) = \left\langle I_a^{\|}(x=0) \right\rangle_t = \tfrac{1}{2} p_o u_o^{\|} = p_o^{rms} u_o^{\| rms}$$

The reader can also easily verify for this example that the ***frequency domain*** active (*i.e.* real) and reactive (*i.e.* imaginary/quadrature) components of the ***complex*** longitudinal acoustic intensity associated with a 1-D monochromatic traveling plane wave propagating in the +*x*-direction in "***free air***" are given by:

$$\tilde{I}_a^{\|}(x,\omega) \equiv \tfrac{1}{2}\tilde{p}(x,\omega)\tilde{u}^{\|*}(x,\omega) = \tfrac{1}{2} p_o \cancel{e^{i(\omega t - kx)}} u_o^{\|} \cancel{e^{-i(\omega t - kx)}} = \tfrac{1}{2} p_o u_o^{\|} = \tfrac{1}{2} p_o u_o^{\|} + 0i = \left\langle \tilde{I}_a^{\|}(x,t) \right\rangle_t$$

Here in ***this*** problem, note that: $\left\langle \tilde{I}_a^{\|}(x,t) \right\rangle_t = \left\langle \tilde{I}_{a\mathrm{r}}^{\|}(x,t) \right\rangle_t + i\left\langle \tilde{I}_{a\mathrm{i}}^{\|}(x,t) \right\rangle_t = p_o u_o^{\|} + 0i = p_o u_o^{\|}$ has ***no*** position (*i.e.* *x*-) dependence!