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Comparison of low frequency ac theory to Langmuir characteristics on the same probe DAVID WALKER, KeyW Corp, Hanover, MD, DAVID BLACKWELL, Naval Research Laboratory, RICHARD FERNSLER, Retired, Naval Research Laboratory, BILL AMATUCCI, Naval Research Laboratory
— The small-signal, ac impedance $Z_{ac}(V_{dc})$ of spherical probes, offers a direct means of determining plasma potential φ_p when the ac frequency ω is low and the probe radius r_p is much larger than the electron Debye length.[a,b] In particular, $\mathrm{Re}(Z_{ac})$ is a minimum at low f when the dc probe bias V_{dc} equals φ_p. Here we compare low-frequency results for $\mathrm{Re}(Z_{ac})$ given by a network analyzer to the dc slope, $(\mathrm{d}I_{dc}/\mathrm{d}V_{dc})^{-1}$, obtained by using the same sphere as a Langmuir probe. The two results agree well at moderate bias over a frequency range $\omega_{\mathrm{pi}}<<\omega<0.3\omega_{\mathrm{pe}}(r_p)$, where ω_{pi} and ω_{pe} are the ion and electron plasma frequencies, respectively.[a] However, the agreement worsens as the bias voltage becomes increasingly negative. Furthermore, because $\omega>>\omega_{\mathrm{pi}}$, we expect the ions to contribute only weakly to the ac current, which suggests that $\mathrm{Re}(Z_{ac})$ should be no less than $(\mathrm{d}I_{dc}/\mathrm{d}V_{dc})^{-1}$. Nevertheless, just the opposite behavior was seen experimentally. We will show results both from earlier work along with recent data in which we use frequencies in the range $\omega<<\omega_{\mathrm{pi}}$.
[a] *Phys. Plasmas* **17**, 113503 (2010); [b] *US Patent* **8,175,827 B2**,(5/2012) .

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