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**Measurements of woodwind tone-hole parameters using a double impedance head method**

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A woodwind tone hole is often represented as a T-junction with a shunt and series impedance. We measured the frequency dependence of the series and shunt impedances of open and closed tone holes using a pair of impedance heads, one on either side of a symmetric section of short bore pipe with a finger hole, and each calibrated on resonance-free loads. The shunt impedance is most accurately measured when the hole is located at a pressure anti-node (speakers in phase) and the series impedance at a pressure node (speakers in anti-phase). We use both conditions, in this way, to measure series and shunt impedances for all frequencies studied.

Pipes with the same length and diameter, but having wall thicknesses 1.5-5.0 mm and tone hole diameters 1.5-15.0 mm were used. For open holes, results are compared with calculations and results measured using other methods. The results for holes closed with fingers are also used to calculate the effective length of finger intrusion. Examples of the inclusion of the results into woodwind models are given.