

## Characteristics of $\pi$ -type attenuators using Ti(N) thin film resistors

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**Abstract** : We report the effect of the film thickness on electrical properties of Ti(N) film resistors. The applications of titanium nitride thin film resistor in  $\Pi$ -type attenuators are also characterized. As film thickness decreases from 100 to 30 nm, temperature coefficient of resistance significantly decreases from -60 to -148 ppm/K, while sheet resistance increases from 37 to 270  $\Omega/\square$ . The characterizations of 20dB-attenuators using thin film resistors are improved in comparison with those using thick film resistors. The  $\Pi$ -type attenuators using Ti(N) thin film resistors exhibit a attenuation of -19.94 dB and voltage standing wave ratio of 1.16 at a frequency of 2.7 GHz.

**Key words:** Ti(N),  $\Pi$ -type attenuator, attenuation, VSWR.