

A COMPACT-SIZED SINGLE MIXER USING LOW-LOSS
BAND-PASS FILTERS BASED ON NRD GUIDE TECHNOLOGY AT 60 GHz

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The NRD guide is a promising candidate in transmission media for construction of novel millimeter-wave integrated circuits. Actually high performance millimeter-wave circuit components such as a Gunn oscillator, a frequency converter, an ASK modulator, and so forth were successfully developed by using unique manners. From among these circuit components, the down-converter (mixer) is a key device in receiving circuits, and a balanced mixer was fabricated using two Schottky barrier diodes and a hybrid coupler. From the viewpoint of size reduction, a single mixer is more attractive than balanced type, and several types of single mixers by using a rectangular metal waveguide and printed transmission lines have been developed based on filter circuits to obtain a good isolation between an RF wave and an LO wave. With this in mind, we developed a band-pass filter based single mixer based on the NRD guide technology at 60 GHz.

In the first place, two types of band-pass filters were designed. They were made of circular ceramic resonators embedded in a thin dielectric sheet, and hence rigidity of the structure was improved. The resonant modes were selected to be a $TE_{02\delta}$ mode for the LO wave and an $EH_{11\delta}$ mode for the RF wave, because the former mode is suitable for narrow band applications, while the latter is preferable for wide-band applications. The measured insertion losses were 0.3 dB for the $TE_{02\delta}$ mode filter at 59 GHz and 0.5 dB for the $EH_{11\delta}$ mode filter at 60 GHz, respectively. Moreover, the isolation between two filters was measured to be more than 45 dB, and thus, a good performance was successfully performed for construction of the single mixer.

By using these filters, a compact sized single mixer was fabricated. The conversion loss was measured to be 7 dB on average in an IF-band of 400MHz at a center frequency of 1 GHz, where the RF and LO frequencies were set at 60 GHz and 59 GHz, respectively.

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