Investigation of Parasitic Effects from Feed and Termination on the Far-Field Pattern of Leaky-Wave Antennas Based on HMSIW

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Abstract: Parasitic effects from the feed and termination on the far-field of two types of leaky-wave antenna (LWA) based on Half-Mode Substrate-Integrated Waveguide (HMSIW) are thoroughly investigated.

It is shown that ripples observed in the radiation patterns originate from discontinuities in the aperture field distribution, which typically appear at the feed and termination.

The paper firstly focuses on explaining the ripples on the pattern of a wideband omni-directional antenna based on a tapered HMSIW. In the second part, the ripples in the highly directive pattern of a uniform LWA are analyzed and compared.

Keywords: Investigation, Parasitic Effects, Feed and Termination, Far-Field Pattern, Leaky-Wave Antennas, HMSIW
Content

I – Radiation Mechanism of Tapered HMSIW

II – Near-Field Distribution

III – Comparison with Uniform HMSIW LWA
A wideband LWA based on a tapered HMSIW fed by a coaxial line:
(a) Top view,
(b) Cross section.
The antenna exploits the radiation loss of the HMSIW close to its cut-off frequency.

The excited wave travels along the tapered HMSIW until it reaches the position where the corresponding cut-off frequency is close to the operating frequency.

In the vicinity of this position the power is radiated intensively due to the high radiation loss from the open aperture.
After the cut-off position, the wave transforms from a travelling to an evanescent mode and decays very quickly with strong radiation loss.

7 GHz

11.5 GHz
Tapered HMSIW LWA Results

Reflection coefficient (left) and radiation patterns of the antenna at two selected frequencies (right).

\( f = 7 \text{GHz} \)

\( f = 11.5 \text{GHz} \)
Near-field is calculated utilizing a semi-analytical solution of the field distribution at the open aperture (N. Nguyen Trong et. al. [3])

A weaker secondary source of radiation located at transition is observed. This radiation interferes with main radiation and causes ripples in the pattern.
Identical antenna with large feeding waveport is simulated.

Radiation of this conceptual antenna exhibits a broad beam with almost no ripples → confirming that the discontinuity at the transition is the dominant source of ripples in this type of antenna.
For the uniform LWA, ripples can be due to parasitic radiation at the load where a discontinuity in the field distribution appears because of antenna termination.

This result also confirms that ripples are due to the finite antenna length.
Conclusion

✓ The electric field distribution in the near-field region of a wideband LWA based on a tapered HMSW has been calculated and compared with simulation.

✓ Compared to a uniform LWA where the ripples can be interpreted as originating from the field discontinuity at load, the ripples in a highly tapered HMSIW come from the discontinuity at the feeding section.

✓ This insight of the impact of the feed will be utilized to design similar antenna with minimized ripples in the radiation pattern.
References

