COMPONENTS FOR THE COLD-TESTING OF A CO-
HARMONIC GYROTRON

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A key design process in the construction of a waveguide 
component is the cold-test stage, involving measuring the 
response of the component to radiation, propagating with a 
specific electromagnetic mode and a certain frequency, or 
range of frequencies. However, for components that require 
high order modes, such as resonant cavities used in high-
power\(^1\), or high-harmonic gyrotrons, it can be challenging to 
generate the necessary mode. A scheme for co-harmonic 
generation of radiation through the cyclotron resonance maser 
instability has been proposed\(^2,3\), involving the generation of 
two harmonics of the cyclotron frequency, with the 
electromagnetic modes stimulated being the TE\(_{2,2}\) and TE\(_{4,3}\).

By introducing a number (2m) of longitudinal slots on the 
walls of a section of cylindrical waveguide, the fundamental 
TE\(_{1,1}\) mode can be suppressed, allowing propagation of a 
specific TE\(_{m,1}\) mode\(^4\). For the cold testing of the co-harmonic 
interaction region, mode launchers for TE\(_{2,1}\) and TE\(_{4,1}\) modes 
would be required, operating within the Ka and W-bands, 
respectively. The initial signal is provided by a side-wall 
coupled TE\(_{1,0}\) signal. A moveable short circuit is installed 
upstream from the feedline, to ensure propagation towards the 
slotted section, as well as to provide tuning of the systems 
reflection characteristics. Simulation predicted bandwidth of 
\(~10\)% for the TE\(_{2,1}\) launcher, at S\(_{2,1}\) levels of better than -5 dB 
in the Ka band, with rejection of the fundamental mode on the 
order of -20 dB. Experimental testing showed excellent 
agreement with numerical predictions, with farfield analysis 
demonstrating the production of the desired mode. Converters 
for the TE\(_{4,1}\) mode have also been constructed and tested, with 
similar performance demonstrated.

Ripple wall mode converters can then be used to obtain the 
required high-order modes. Such devices are cylindrical at 
either end, with a slight sinusoidal ripple in the outer radius, 
over a large number of periods. Numerical and experimental 
results have shown the production of a TE\(_{2,2}\) mode with a 
bandwidth of \(~200\) MHz, at a centre frequency of \(~38\) GHz.

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