PULSE WAVE PROPAGATING IN COPLANAR WAVEGUIDES (CPWS) ON LTCC SUBSTRATES

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Received 17 September 2002

ABSTRACT: The propagation of pulse waves in coplanar waveguides (CPWs) is investigated, and these CPWs are assumed to be fabricated on a single-layer low-temperature co-fired ceramic (LTCC) substrate. The input pulse wave can be a Gaussian pulse or a sinusoidally modulated Gaussian pulse. Based on the standard Galerkin's method in the spectral domain, combined with fast Fourier transform (FFT), the pulse waveform and delay in CPWs are demonstrated and compared for
a second plate, oriented orthogonally to the primary planar ele-
ment, thus producing a crossed planar monopole (CPM), which is
simpler to produce and has lower cost than a conical monopole. In
this paper, further measurements have been made on this element.

ANTENNA GEOMETRY AND IMPEDANCE PROPERTIES
The simple planar monopole consists of a planar element that is
fed using an SMA feedprobe. The planar elements were con-
structed using a 0.2-mm-thick copper sheet and the groudpplane
dimensions were 100 × 100 mm. This simple square planar
monopole of dimension \( L = W = 18 \) mm, with a feedgap of 2
mm, has a return loss (RL) greater than 10 dB from 2.95 to 6.9
GHz. The upper-edge frequency (10-dB RL) is extended to beyond
10.5 GHz by using a 20° bevel. The lower-edge frequency is not
significantly changed by the bevel. The geometry for the simple
planar monopole with bevel (SPMB) is illustrated in Figure 1(a).
The crossed planar monopole (CPM) comprises a second planar
element added and oriented orthogonally to the original element,
as illustrated in Figure 1(b). The width of each element was
reduced to \( W = 9 \) mm, which maintains the same surface area as
the simple planar monopole. The return loss plots are shown in
Figure 2 for these antennas. The lower edge frequencies for the
SPMB and CPM are 3.0 and 3.1 GHz, respectively. The upper-
edge frequency for the CPM is 9.55 GHz, but still presents a 9-dB
return loss at 10.5 GHz.

STABILITY OF RADIATION PATTERN
One of the challenges in wideband planar antennas is maintaining
an omnidirectional pattern as the frequency increases, which is
readily observed from \( H \)-plane plots. Radiation patterns have been
measured at 2.4, 4.8, 6.8, and 9 GHz for the bevelled planar
monopole and the crossed planar monopole. The \( H \)-plane patterns
\( E_\theta(\phi, \theta = 90) \) are illustrated in Figure 3. At 2.4 GHz, both
patterns were purely omnidirectional (they are not shown for the
sake of brevity). It can be seen that the simple planar monopole
with bevel exhibits distortion in the pattern, particularly at higher
frequencies with broad nulls up to a depth of 9 dB at 9 GHz. In
contrast, the patterns for the crossed planar monopole remain very
stable with frequency with a maximum deviation of 2.8 dB from a
purely omnidirectional pattern at 9 GHz. The patterns are nor-
malised to maximum gain, which is 4.3 dBi at the lower frequen-
cies and increases with frequency to about 6.0 dBi.

CONCLUSION
The addition of a second planar element orthogonal to the planar
monopole improves the radiation pattern stability without degrad-
ing the ultra-wideband impedance characteristics.

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