Impedance Matching Improvement for a Class of Wideband Antennas

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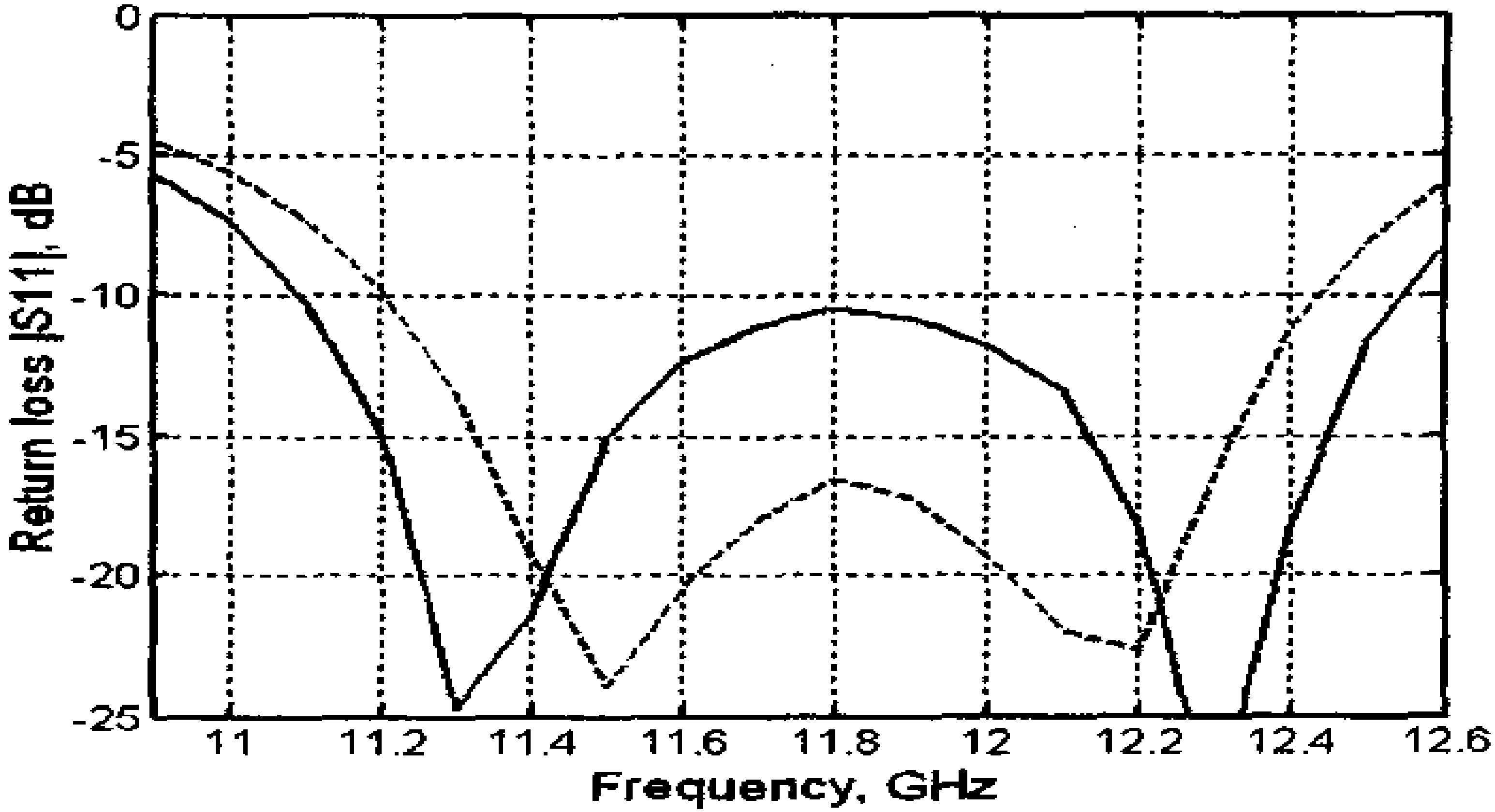
Problem

- Linearly polarized antennas has a very serious limiting factor which is a narrow impedance bandwidth
- Introducing dual (or multiple) resonances in the impedance characteristic of the antenna is a possible suggested solution.
- The basic problem in this class of antennas is the high value of the retun loss within the antenna bandwidth
- In addition, in antennas with an even number of resonances, the impedance matching is worst at the design (operating) frequency
- The use of a usual (classic) quarter-wavelength transformer improves the impedance matching at the middle frequency, but unfortunately decreases the bandwidth

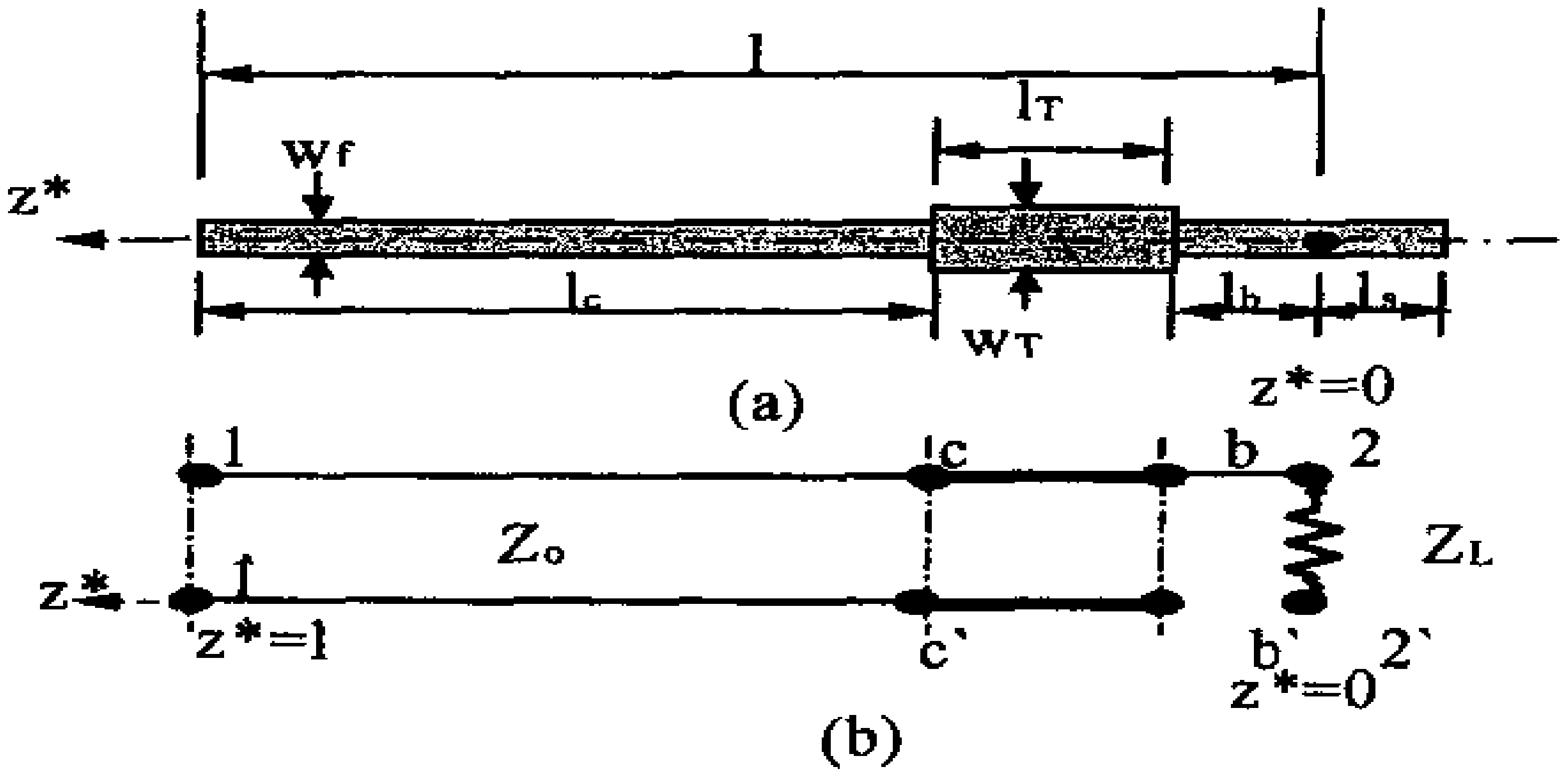
Proposed Solution

- A simple and efficient technique for improving impedance matching within the antenna's bandwidth is needed, these antennas have two resonances.
- A quarter-wavelength transformer to match the antenna to the feed line is also used.
- The proposed solution has been applied to a wideband aperture-coupled microstrip antenna that has a resonate slot.
- This resonate slot has the effect of approximately doubling the antenna's bandwidth, but decreases the impedance matching within the antenna's bandwidth



The return loss of an aperture-coupled microstrip antenna without matching (solid line) and with matching (dashed line)

The patch is responsible for the low frequency resonance, ***f1****, and the aperture (the slot) is responsible*for the high-frequency resonance, ***f 2***

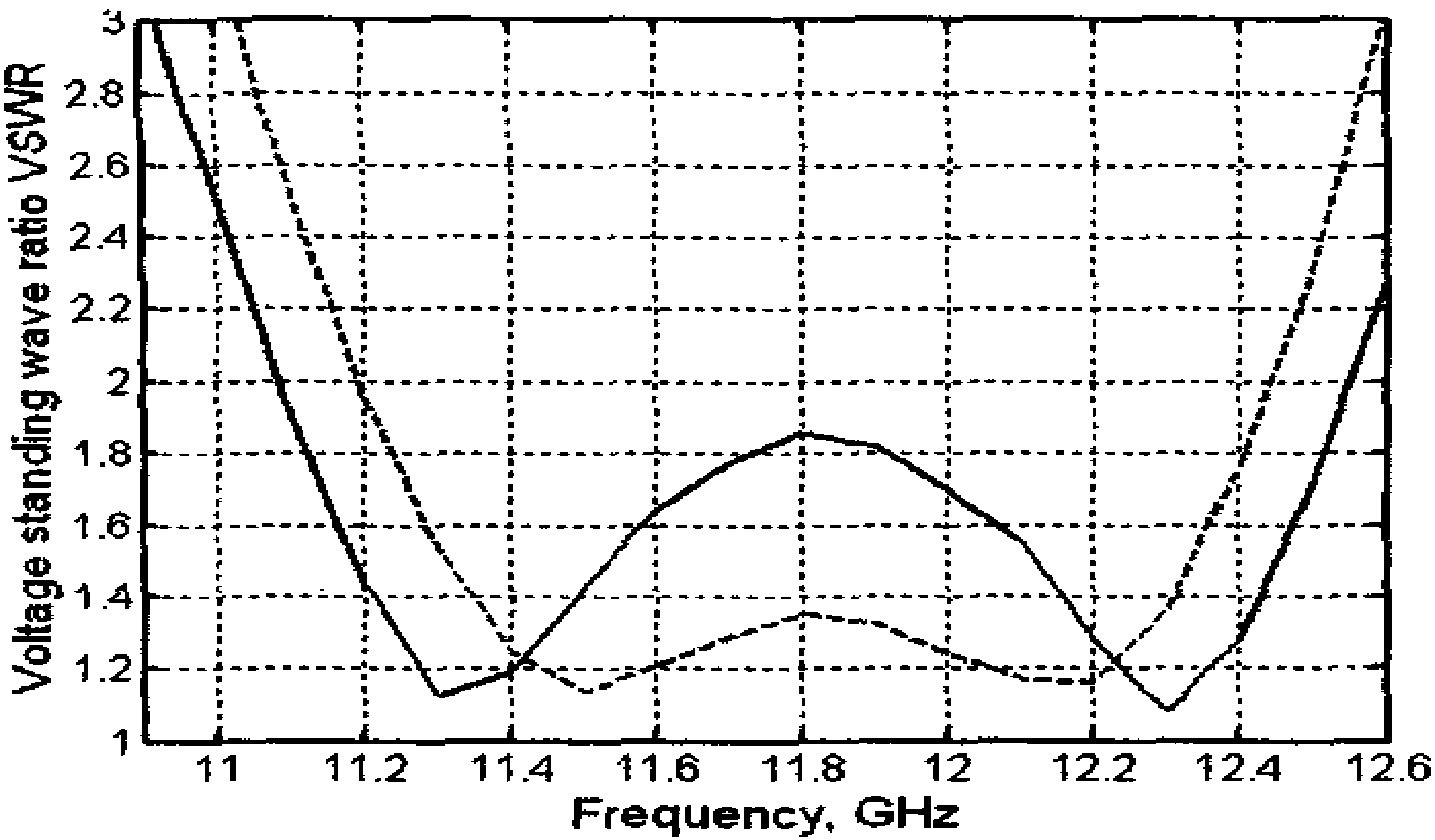


The microstrip feed line and its equivalent circuit. Normal TL analysis follows, the quarter-wavelength transformer must be placed a distance ***l_b*** away from the load at point z*=0, where the input impedance toward the load at *z** = ***l_b*** is real. The distance ***l_b*** can be found from Equation *$x(l_b)=0$*

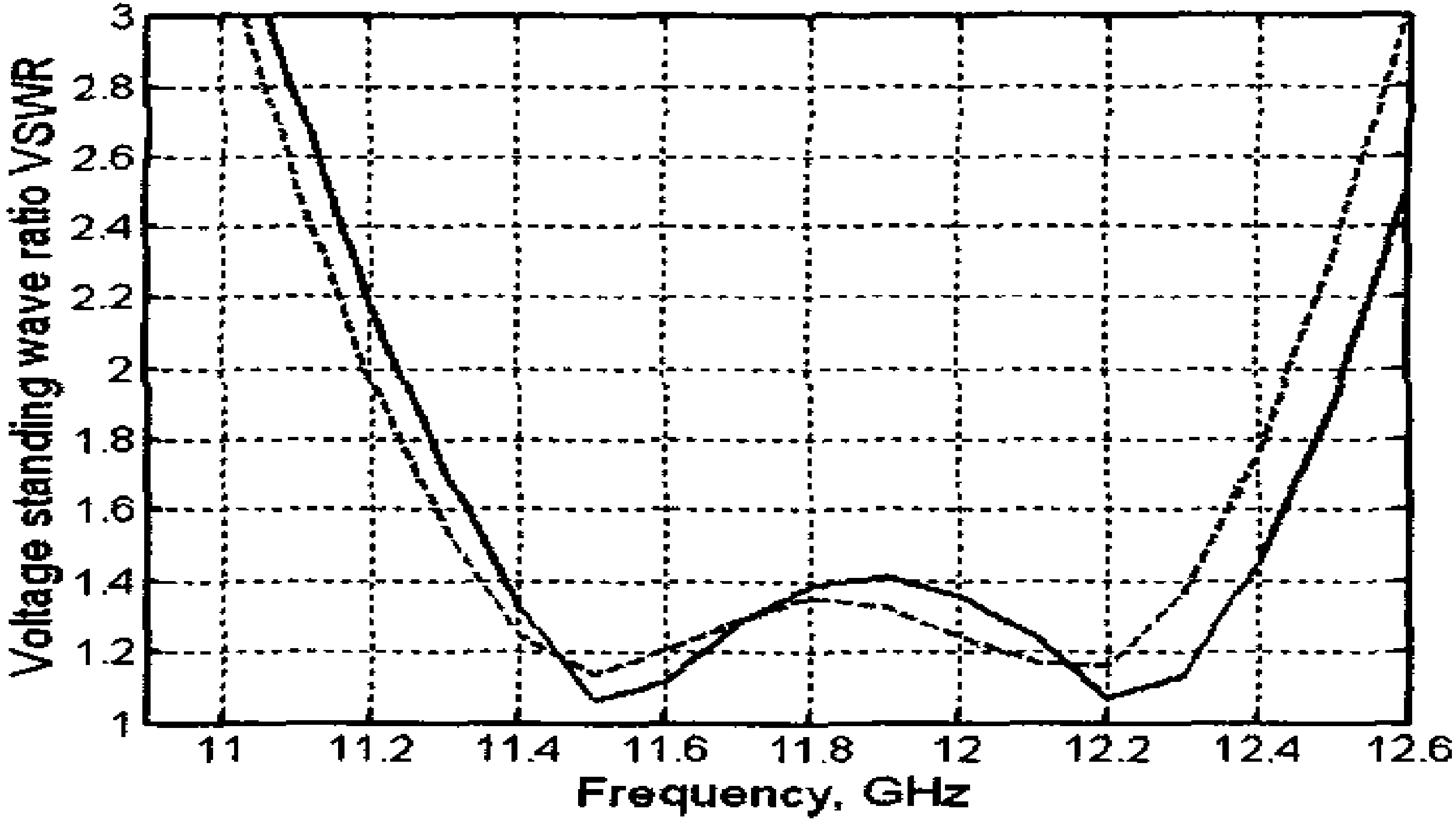
- The expression used to calculate the characteristic impedance of the quarter-wavelength transformer at $z^* = l_b$ *and* $f = f_o$ *is* $Z_{0T} = \sqrt{Z_0 R_{b0}}$, where R_{bo} *is the impedance (real,* $Z_{bn} = R_{bo}$, $X_{bo} = 0$*) of the* feed line at $z^* = l_b$ and $f = f_o$
- Accordingly, the impedance matching at $f = f_o$ *improves*. On the other hand, this leads to a matching degradation at *both* $f=f_1$ *and* $f = f_2$.
- We propose to use the following expression to calculate the transformer characteristic impedance:

$$Z_{0T} = \sqrt[4]{Z_0^2 R_{b0} \sqrt{R_{b1} R_{b2}}} ,$$

where R_{b1} *and* R_{b2} are the impedances of the feed line at $z^* = l_b$ at $f \approx f_1$ *and* $f \approx f_2$, respectively. One may see that in the *case* where $f_1 = f_2 = f_o$ *and* $R_{b1} = R_{b2} = R_{b0}$ both expressions are equivalent



The VSWR of the aperture-coupled microstrip antenna without matching (solid line) and with matching (dashed line).



A comparison of the aperture-coupled microstrip antenna's bandwidth with the proposed matching for simulated (dashed line) and measured (solid line) antennas.

A comparison of the values of the antenna's bandwidths with and without matching.

Type of Feed Line	$VSWR < 2$	$VSWR < 1.35$	$bw_{1.35}/bw_{2.0}$
Feed line without matching	12.4 %	3.6 %	29 %
Feed line with proposed transformer	10.5 %	8 %	76 %