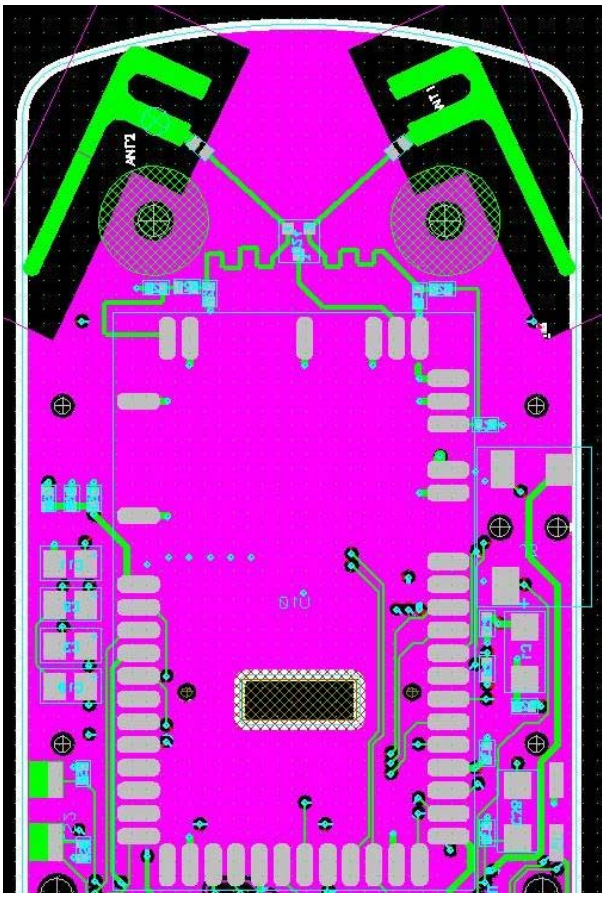
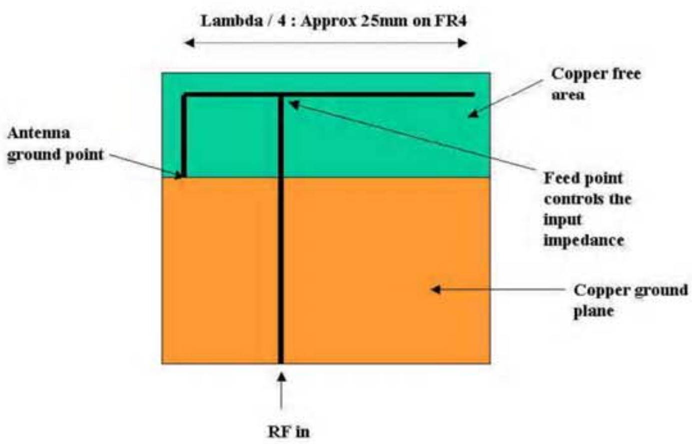
Internal antenna in iMEDIA RF Controller



Antenna design concept

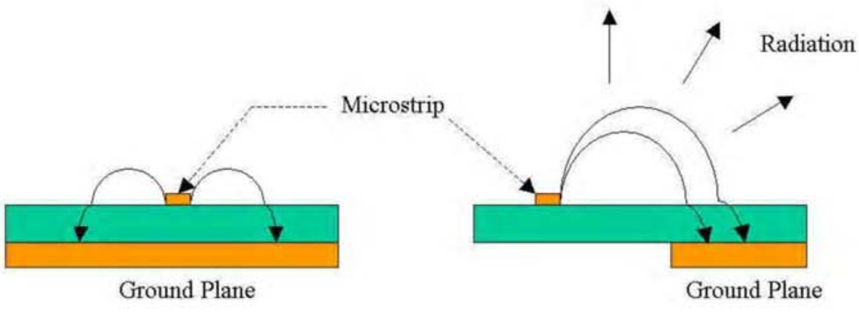
Printed Inverted F (PIFA)



A PIFA antenna is shown above. The main radiating element is λg/4 in this case, or it could be half or full λ for better RF performance. The back of the element is grounded with through via's placed close to the grounding point to give a good RF ground, this is to provide a node where the electric field is close to zero. The radiating element being quarter wavelength will produce an anti-node on its other end where the electric field is strongest, hence this end of the element will become the active radiating region of the antenna. An area of ground plane and copper clearance is again required to give the antenna its required bandwidth. The antenna element is approximately 25mm long since it is printed on FR4, this is considerably larger than the dielectric chip, but of course this kind of antenna will be cheaper to manufacture than the dielectric chip at the expense of size. The position of the feed point along the element will control its input impedance to a certain extent and can be used as a tool for matching along with the antenna dimensions and a discrete matching network.

Principle of Surface Mount, Printed or Patch Antennas

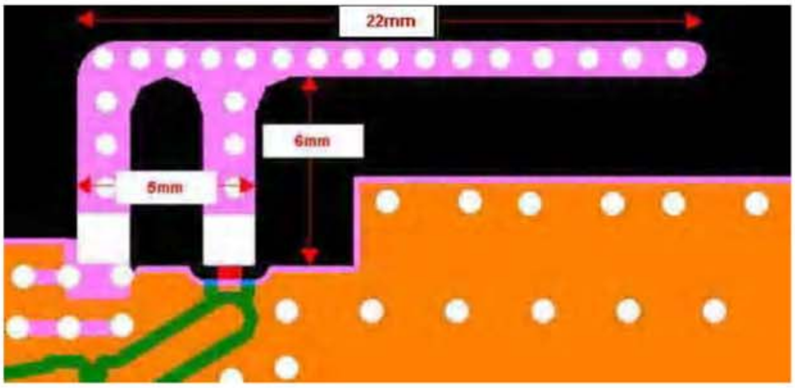
All such antennas work on a similar principle, radiating element, clearance around the element (top and bottom) plus a ground plane on one side. It is necessary to create a fringing E-field with a large arc to give rise to radiation emission, else the field will be contained and non-radiating.



Consider a micro-strip line as shown above and the electric field lines that run from it through the dielectric substrate to ground. Although micro-strips do radiate a little, they are not good antennas by themselves. In order to turn them into good radiators it is necessary to move the ground plane from under the strip-line, hence forcing the electric field to arc over a greater distance, and it is this arcing field that produces the radiation. If the ground plane is moved too far, then the electric field would cease altogether, therefore there is a critical distance.

Reference Design: Example

The physical dimensions of the antenna are predominantly governed by three factors, the frequency of resonance, the dielectric constant of the substrate on which the antenna element is printed and the thickness of the substrate. High frequency obviously means smaller dimensions, also high dielectric constant and thick substrate means the field lines are more densely packed, which means smaller physical size.
In this example for the CVM module (at 2.45GHz center frequency) the relative dielectric constant is 4.3 and the thickness of the substrate is 1mm.



In this case the maximum dimension of the antenna is 17mm, $\lambda g/4$. The antenna could also be 34 or 68mm long, $\lambda g/2$ and full λg respectively, depending on space available. The advantage of making it larger is greater bandwidth and immunity to de-tuning.

Monopole antenna

A monopole antenna is a dipole that has been divided in two and is fed against a ground plane. The ground plane projects a virtual image of the monopole, which then behaves as a dipole, but one half of the antenna is imaginary.
A practical monopole can be created, as shown below, by a simple piece of wire that is tuned to resonant length and the ground plane consists of radial projecting wires perpendicular to the radiating element.

The length of such an antenna can be $\lambda g/4$ or approx. 3cm at 2.45GHz, however in reality it will be slightly less than this due to the fact that the λg is different from free-space λ.
Such a monopole will have very good performance and bandwidth. But projects from the side of the application and is recommended only where there is no shortage of space to put it.