September 2011
Volume 117
Issue 1905
£4.60

www.electronicsworld.co.uk

Electronics WORLD

THE ESSENTIAL ELECTRONICS ENGINEERING MAGAZINE

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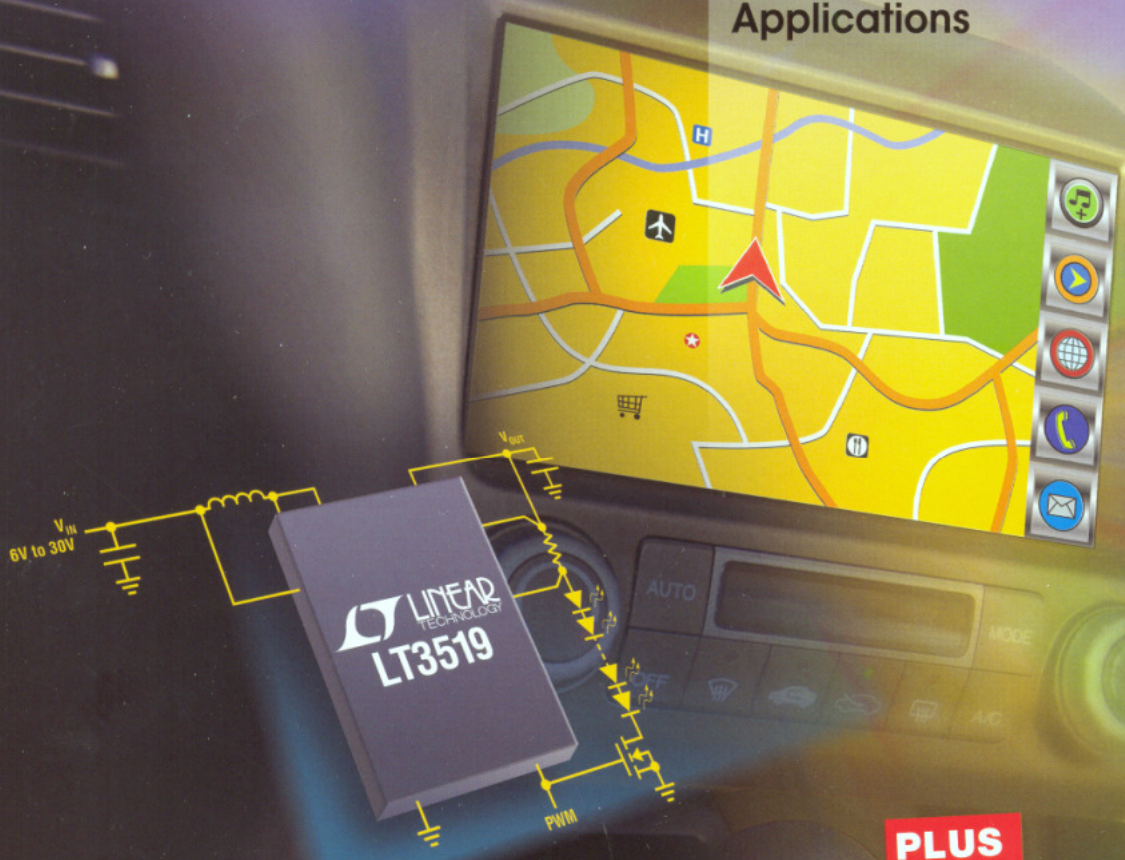

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END OF THE ELECTRIC CURRENT AS WE KNOW IT?

THE DEBATE CONTINUES ON THE LETTERS PAGE

WHAT THE READERS SAY

Barry McKeown (Letters, EW, January 2011) wonders why no reader has questioned the mathematics of Ivor Catt's recent series of articles. That omission can be rectified.

If L is the inductance of a length s of twin-conductor cable and C is the capacitance, then the inductance per metre and the capacitance per metre can be defined as: $\frac{dL}{ds}$ and $\frac{dC}{ds}$.

Electromagnetic theory derives formulae for the voltage V between the conductors and the current I in the conductors at any point on the line at time t. If it is assumed that there are no copper losses or dielectric losses, then:

$$\frac{\delta V}{\delta s} = \frac{dL}{ds} \cdot \frac{\delta I}{\delta t}$$
$$\frac{\delta I}{\delta s} = \frac{dC}{ds} \cdot \frac{\delta V}{\delta t} \quad (1)$$

where the symbol indicates a partial derivative.

Equations 4 and 5 in the article *'The end of electric charge and electric current as we know them'* (Ivor Catt, EW January 2011) can be re-written as:

$$V = \frac{dL}{ds} \cdot I \cdot \frac{ds}{dt}$$
$$I = \frac{dC}{ds} \cdot V \cdot \frac{ds}{dt} \quad (2)$$

Ivor has ignored the fact that current and voltage can vary along the length of the line.

If the initial equations are wrong, then so are any equations derived from them. Conclusions as to the physical nature of current propagation, derived from the use of faulty mathematics, can only be taken with a pinch of salt.

In his opening statement, Ivor declares *"We see two electric currents travelling in opposite directions down a single conductor. Conventional electric current is not fit for purpose."* He appears to consider the fact that current can travel in two directions along a conductor as an amazing revelation.

There is nothing new in this concept. The phenomenon is described in every textbook on electromagnetic theory. Every designer of radio frequency equipment is well aware that reflections occur at every discontinuity in a transmission line, and that the actual current at any point on the line at any instant is the sum of a number of partial currents. Circuit theory, which is a development and simplification of electromagnetic theory, caters for this effect by the use of mesh analysis.

Ivor's articles are based on the content of an academic paper in an old journal. The researcher who carried out the original work has not been given any credit. There is no mention of the title of the paper, the name of the journal, nor the date it was published. Only the skimpiest description possible is provided of the actual experiment. There is no data on the equipment used, the setup, the test method, or on the scaling of the oscilloscope traces. It is impossible to repeat the experiment using the information provided by Ivor.

Even so, credit should be given where credit is due. Ivor has identified a phenomenon which is not even alluded to in any book on electromagnetic theory; a short, sharp, transient pulse separates out into two different components as it propagates down a transmission line, with one component travelling faster than the other. Further investigation is called for.

It should be possible to devise an experiment which enables the pulse to be observed as it propagates down the line. Close examination of the scope waveforms should allow a model to be produced which replicates the response. Assessment of the model will provide a clearer insight into the electromagnetic coupling mechanisms. Improved understanding of the physics will enable us to control the glitches which bedevil the performance of many logic circuits.

Perhaps Ivor could help in such a project?

IVOR CATT REPLIES:

In reply to Ian Darney's comment: *"Ivor has ignored the fact that current and voltage can vary along the length of the line"*, I would like to say that the reason why the TEM Wave has been so confusing is because it has been treated as a sine wave. It is much easier to grasp if current and voltage are kept constant, as I do, and as occurs in digital systems. Seeing only sine waves (using Fourier Series), it may not be easy to grasp the obvious flaws in theory illustrated by *"The Catt Question"* and now in January/ February 2011 of Electronics World.

In reply to Darney's comment: *"In his opening statement, Ivor declares 'We see two electric currents travelling in opposite directions down a single conductor. Conventional electric current is not fit for purpose'. He appears to consider the fact that current can travel in two directions along a conductor as an amazing revelation. There is nothing new in this concept"*, I say that the idea that electrons will hop along down a conductor in both directions, waving to each other as they pass, is truly amazing.

In reply to Darney's comment: *"Ivor's articles are based on the content of an academic paper in an old journal. The researcher who carried out the original work has not been given any credit. There is no mention of the title of the paper, the name of the journal, nor the date it was published"*, I say the relevant paper is by Ivor Catt, now at

Papers referred to; ivorcatt.co.uk/x0305.htm and ivorcatt.co.uk/cattq.htm

Figure 1: Printed circuit board used Figure 2: Active conductor at input, 3 metres and 6 metres

Figure 3: Passive conductor at input, 3 metres and 6 metres

...t.co.uk/x0305.htm.

In my series of articles published in Electronics World in January, I wanted to explain that we have a revolution in science – the relegation of "electricity" along with phlogiston and caloric. No such major scientific advance has occurred for a century. Worldwide, all relevant academic parties have refused to comment on the article. This delays the time bomb.

High-speed digital electronics exposed impossible flaws in the traditional concept, which were not noticed or ignored/suppressed for half a century. "Electricity" is merely the edge of an electromagnetic field. It no more exists than does the slope of a hill, which is merely dh/dx. The real stuff is h and x, as electromagnetic field is real. Nowhere else in the history of science has the mere mathematical manipulation of something real (electromagnetic field) been thought to be real (electricity).

A very narrow voltage/current pulse was injected into the left-hand active conductor adjacent to a parallel passive conductor, with the front of the passive conductor now shorted to ground. Three metres along, the narrow pulse separated out into two pulses, and two equal and opposite pulses appeared on the passive conductor. In Electronics World in January 2011, p20, using Faraday's Law of Induction and the Law of Conservation of Charge, it was proved that only two wave front patterns can be sustained in such a system. These are the Even Mode, where the two conductors are at the same potential and carry electric current in the forward direction, and the Odd Mode, where the two conductors are at equal and opposite potentials and carry electric current in opposite directions.

The earliest, lowest traces are neither. They show a third, illegal, unbalanced mode. Further, the first, lowest trace on the right must be showing electric currents travelling in opposite directions

Figure 1:

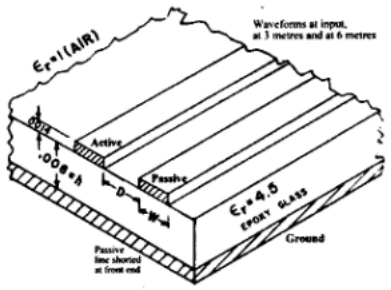
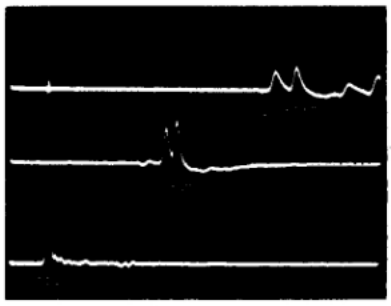


Figure 2:



along the same conductor at the same time. This is further evidence that electricity is not fit for purpose. Previously, In Electronics World in May 2009 ...//www.ivorcatt.co.uk/catto.htm, *"The Catt Question"* showed us that, in order to get to where it had to, electric charge had to travel at the speed of light – giving it infinite mass. Now we find electric currents travelling in both directions along a conductor. The answer to this nonsense is to get rid of electric charge and current, and reduce them to merely mathematical manipulations of the electromagnetic field. To do this, we might use Maxwell's Equations, which link field to electricity.

Darney also writes: *"Even so, credit should be give where credit is due. Ivor has identified a phenomenon which is not even alluded to in any book on electromagnetic theory; a short, sharp, transient pulse separates out into two different components as it propagates down a transmission line, with one component travelling faster than the other. Further investigation is called for."*

What is so fascinating is that in 1964 I had to rediscover the two modes, Even and Odd. They were already known – but not proven – in microwave engineering, as a nuisance feature. However, there is no evidence that they knew about the two velocities. This is all very thoroughly

Figure 3:

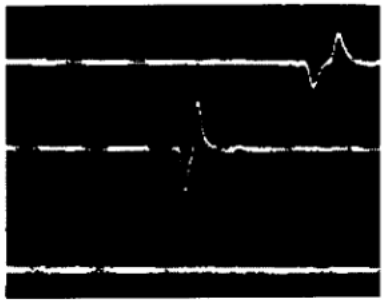
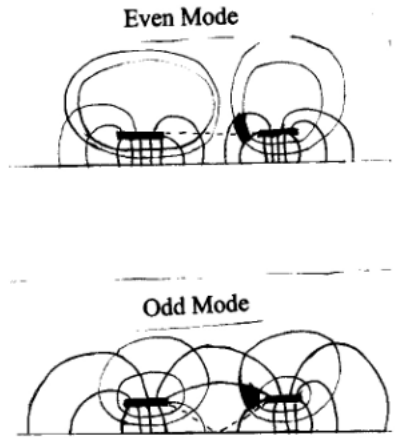


Figure 4:



discussed in my 20 page 1967 IEEE paper now at ...//www.ivorcatt.co...htm

As to not alluding to this in any book, one can go further. As the years go by, books on electromagnetic theory "allude" to less and less of the key factors in electromagnetics, while at the same time advancing from 200pp to 500pp and £20 to £50. Today's lecturer has no access to much more fundamental information than these two velocities.

For instance, he cannot find out the relative phase of E and H in a TEM Wave. Not one text book tells him, and Google information gets it wrong. The fundamental features of digital electronics are not addressed in any text book except mine, which is not used. Theory is frozen at 1960, and takes no advantage of the experience of digital electronics, now 90% of electronics.

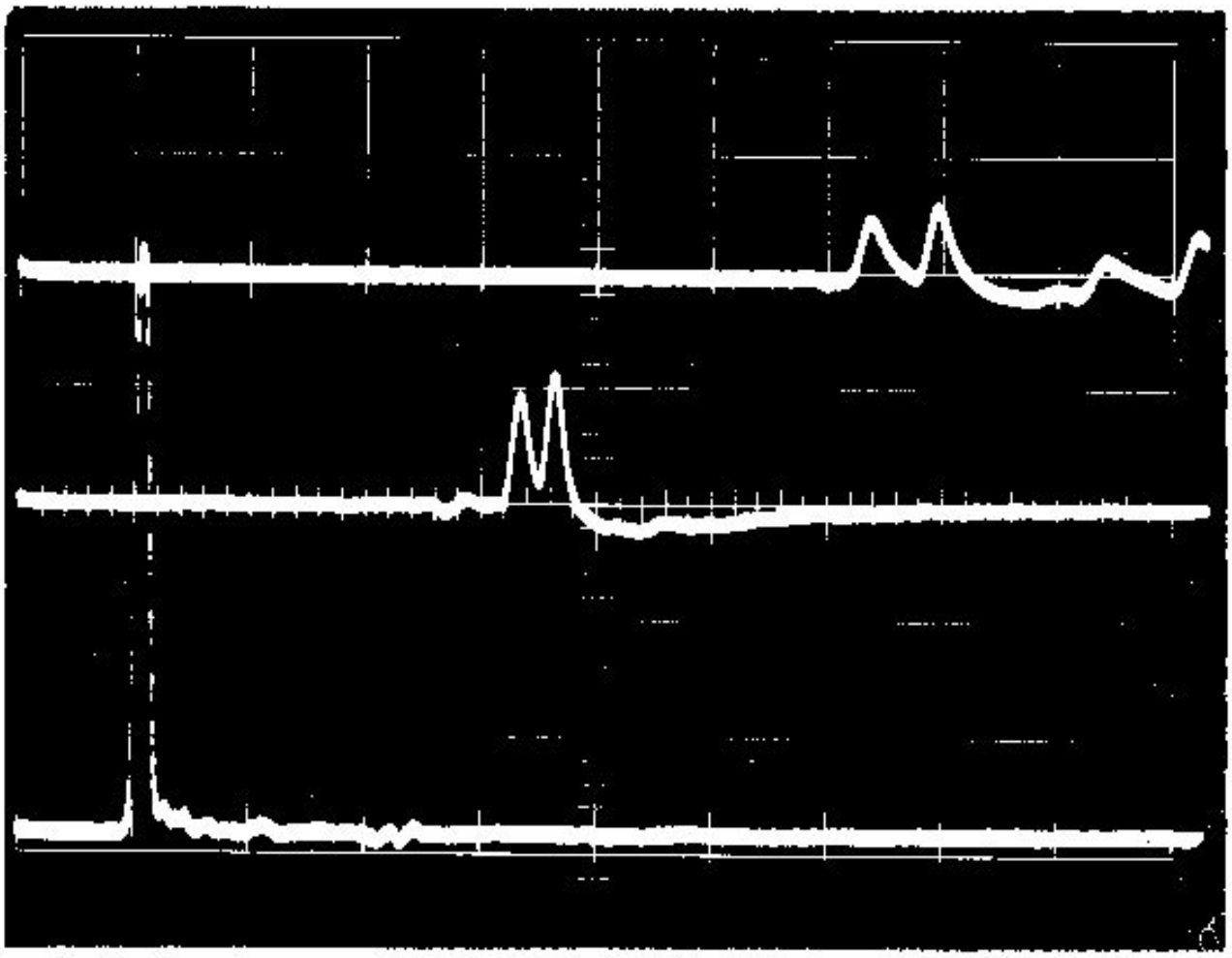


Figure 2: Active conductor at input, 3 metres and 6 metres Reflection from open circuit

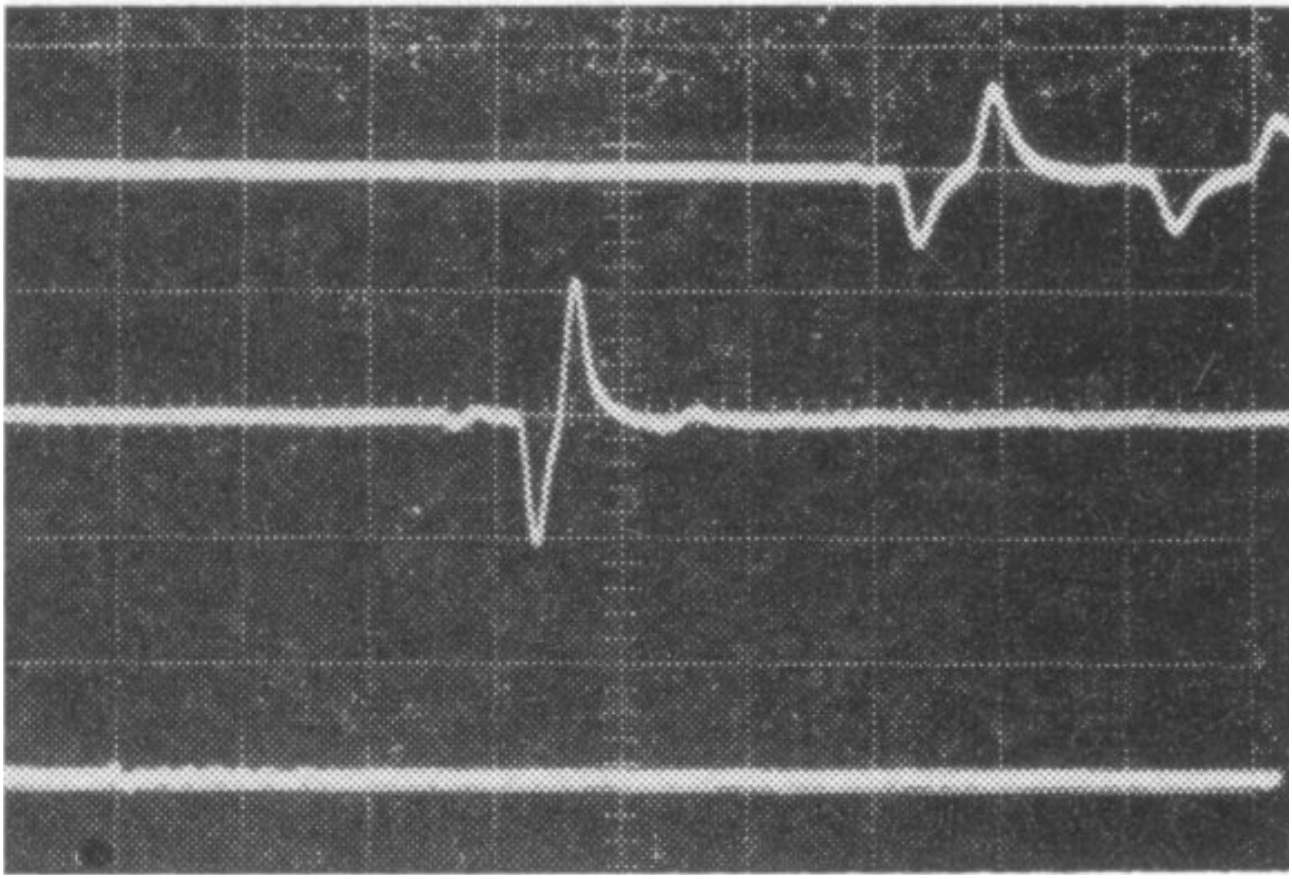
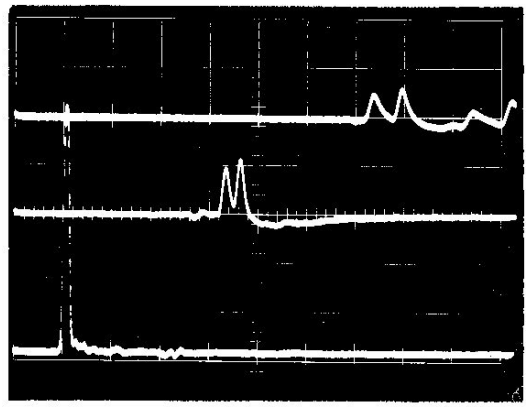
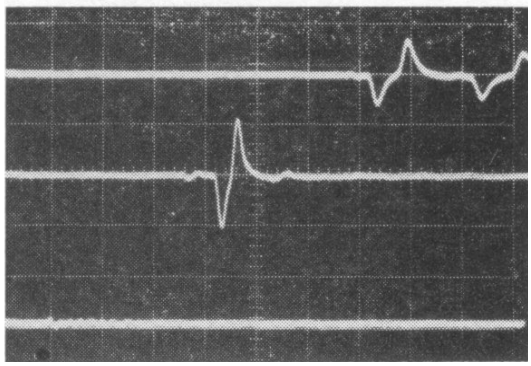
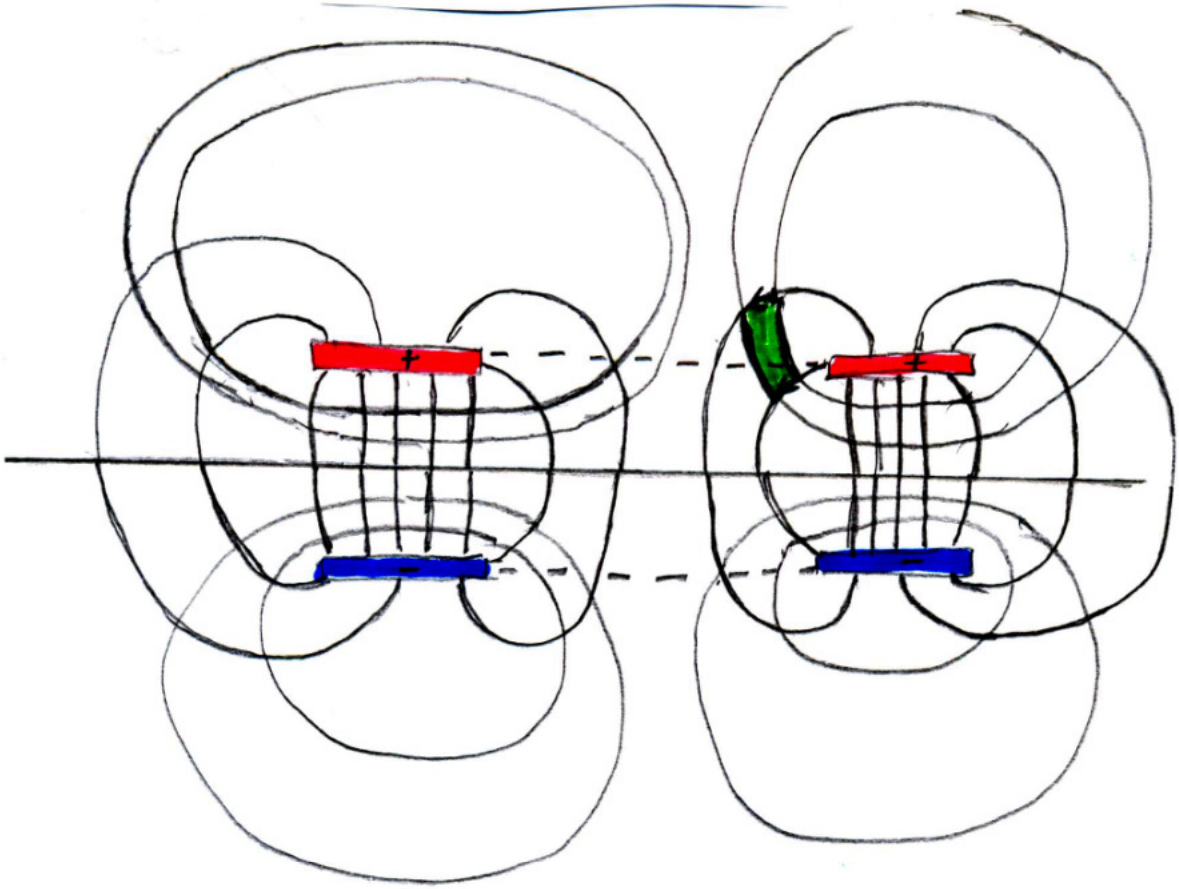


Figure 3: Passive conductor at input, 3 metres and 6 metres o/c reflection





Even Mode



Odd Mode