Coax Cable Paper PhL 2.12.14

I wrote this in late October 1991. There was a serious question at the time as to whether you really could run HDTV signals through coax cable like Belden 8281. The conclusion of my paper is that yes you could, but that Belden 9292 would go for a longer distance.

I wrote this paper after writing the Transmission Lines paper in the previous month. I just wrote the notes below, but they are very close to the summary on the first page of the binder.

Question: Should I clean this up and put it on line? My answer is no.

First of all, this is not a general topic like "transmission lines" or "tensor analysis". It is very specific, and the subject is probably no longer of interest since we all know that the Belden cable works just fine and equalizers make up for problems.

Secondly, Belden has updated its cables, and my two numbers don't even appear in their HD section, though they still make the older cables (at least you can buy the stuff). They now have special cables for digital HDTV up to 4.5 GHz with all new numbers. So my 23 year old writeup would be of no interest to anyone. I am now downloading their current "master catalog". The older cables are Brilliance ones and are only rated up to 1 GHz.

Thirdly, this is the closest paper to being proprietary that I did. I used BTS equipment, and it was for a company research effort. So more than all the other papers, Philips or whomever really owns this paper.

Fourth, I don't want to take the time to do it. The lines doc took 5 months!

Fifth, the subject just does not interest me right now. Ironic that Belden is now buying BTS! Maybe those HD cables are a major part of its business nowadays. Beldon does 2B rev with 200M profit, why would they spend 220M buying Grass?

Chapter 1 Introduction. Here I describe the parameters of coax cable with emphasis on the loss tangent $\tan_L$ thing which is where most cable attenuation comes from. I talk about skin effect and how it increases wire resistance. but I don't see the phrase "surface impedance" being used. I have a long discussion of polyethylene and its variations. In this paper, for coax cable we have $K = \ln(b/a)$ and $C = 2\pi\varepsilon/K$. In my rewritten lines doc, I have instead $K = 2\ln(b/a)$ so my new K is twice my old K.

old K	$K_{old} = \ln(b/a)$	$C = 2\pi\varepsilon/K_{old}$	
new K	$K_{new} = 2\ln(b/a)$	$C = 4\pi\varepsilon/K_{new}$	$K_{new} = 2K_{old}$

Everything in this chapter seems familiar after my recent lines effort, but things are perhaps stated in a different way, thinking of the coax cable. I must have done some library time because there are many copies of things at the end of this chapter.

Chapter 2 High Frequency Model. All old hat, though I do mention group velocity which does not appear in lines doc. I make some kind of "high frequency model" which I imagine in lines doc is what you get from the high ω limit of Z_s. I do make use of these dimensionless parameter ratios,

$r_e = R/\omega L_e$ $g = G/\omega C = \tan_L$ (11) Chapter 2

which do not appear in lines doc. In (4) I write

$$\gamma = \alpha + j\beta = \sqrt{\mathbf{zy}} = \sqrt{(R+j\omega L)(G+j\omega C)}$$

and from the TL equations this is the z direction k number, so α is decay and β is phase as in (5). So I come up with equations for all these parameters such as page 5 (18) for attenuation α. I then add the tinning correction and summary is on page 9. I am not following the details. β_1 is the dielectric β same as in lines for region 1. I goof around getting α and β as approximations when there is no loss from the messy radical above.

Why is this a large ω model? I guess at large ω the losses are going to be low. Skin effect limit etc.

Appendix on tinning correction.

I just added the above attenuation relationship to lines doc since it was missing!

Chapter 3: Case Study of Belden 8281 cable. Here I compare the high ω model of Chap 2 with measured properties of the Belden cable. Very energetic of me. I imagine what an ideal cable would look like, and it comes out being Belden 9292.

Chapter 4: Low Frequency Model. So this is a repeat of Chapter 2 in the small ω case. Again we have parameters α and β, it is all summarized on page 9. Then I try to join the large and small ω models.

Chapter 5: Time Domain Studies of Belden 8281. I consider pulses and Fourier stuff. I even have a little coax.c program that does something. Then plots from the CSA 803 analyzer instrument. Rise time, delays, pulse shape. Barry eventually put receiving equalizers into products

Chapter 5: Time Domain Studies of Belden 9292. Similar to previous chap, but much shorter.

There are no formal References.