Can two-wire common mode chokes be used in coaxial transmission line systems ? pa0nhc V20220524-5

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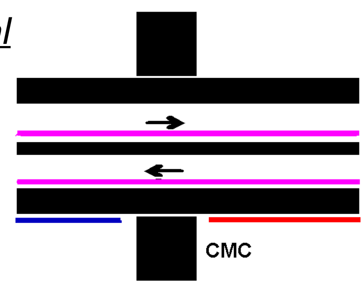
|---|---|
|  Coaxial CMC. |  Two-wire CMC. |

K9YC concludes in one of his articles :
"Two-wire CMCs also work well in coaxial transmission line systems.”.
But is this true ?

## The coaxial CMC.

Drawing 1 represents a simplified cross section of a *coaxial* cable with a ferrite core around it. Together they represent a coaxial Common Mode Choke (coaxial CMC).



*Drawing 1.*

From now on for simplicity we accept, that a ferrite core around a coaxial cable, or over a two wire transmission line, induces a high series impedance in its common mode circuit.

In Drawing 1 we see a coaxial CMC. The “Purple” lines represent the differential mode currents. Both currents are equally strong but run in opposite direction. They are “balanced” and do not radiate any external magnetic RF field.

“Blue” and “Red” represent common mode currents, running on the outside surface of the coax screening. The ferrite core induces at its position a high value of series resistance in the common mode circuit. Common mode currents therefore cannot run further at the location of the ferrite core. The “Blue” current cannot reach the “Red”current and vice versa.

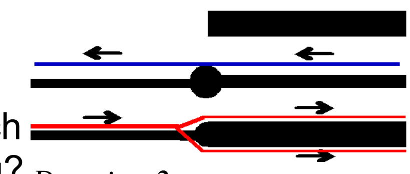
Due to the “Skin effect” in the coax screening, these common mode currents also cannot make contact with the purple differential mode circuit .

As the balanced “Purple” common mode current pair does not generate a magnetic RF-field, the ferrite core cannot influence this “not existing RF-field”. A ferrite core has therefore no influence to the differential mode circuit.

All this is well known theory.

## The problem.

In Drawing 2 we see the sketch of (left) a balanced two wire (twin-line) transmission line (“chicken ladder”), which is connected to (right) a coaxial cable. What goes wrong?



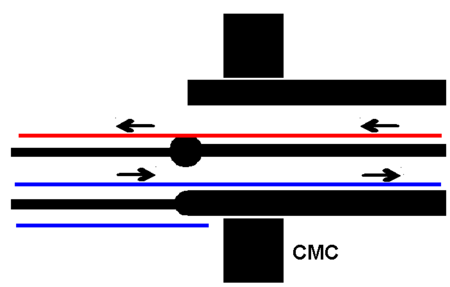
*Drawing 2*

The lower (Red) wire of the chicken ladder is connected to the ***open*** end of the coax screening. The “Red” current can now not only run into to the *internal* differential mode circuit of the coax cable, but also to the *external* common mode circuit.

In fact, the lower wire of the twin-line ***interconnects*** **both coax common mode- and differential mode circuits**. This has a noticeable impact.

Lets imagine “Red” currents running in the other direction :
The on the outside of the coax induced RF-noise-currents, can at the end of the screening, go into the inner side of the screening. The coax feed line part will now act as a parasitic antenna.

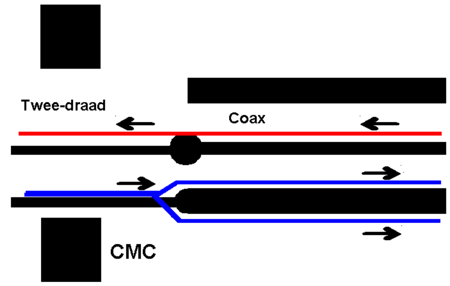
In Drawing 3 we see the same coax-twin line combination. But this time a ferrite core is placed over the *end of the coax* piece. This combination results into a coaxial CMC .
*Now the “Blue” current on the lower twin line wire cannot pass onto the common mode circuit* of the coax cable. Resulting in no common mode current on the coax, nor in the twin line. Now the total transmission line does not radiate RF-power.




*Drawing 3*

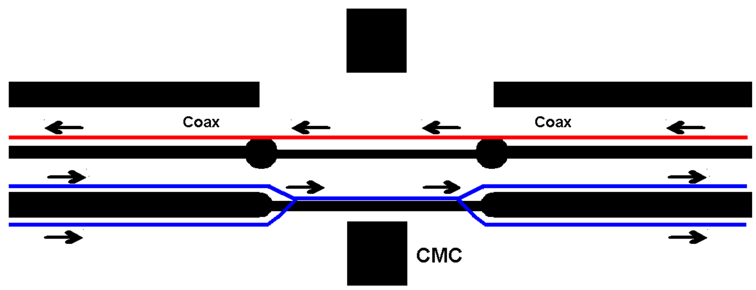
This is the correct way to connect a balanced twin line to an unbalanced coax feed line.

In Drawing 4 we see the same twin line, connected to a coax cable. But this time is the ferrite core shifted to the left, over the end of the twin line. This results in a *twin line* CMC at the end of the twin line. Common mode currents in the twin line are blocked. But the lower CMC wire again interconnects the common mode and the differential mode coax circuits. At the end of the coax screening, common mode currents on the outside of the coax screening still can jump into the differential mode circuit of the coax cable. The coax cable is again acting as a parasitic antenna.



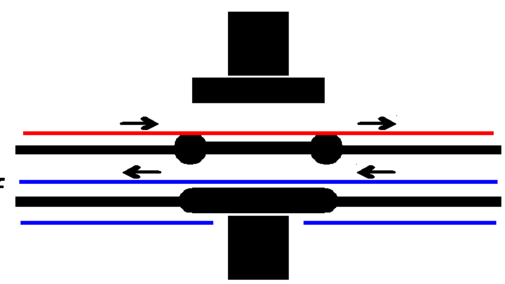
*Drawing 4*

In Drawing 5 we see two pieces of coax, connected by a <u>*twin line*</u> CMC. Here also are both ends of the coax screenings interconnected, resulting in <u>***two***</u> *coaxes acting as parasitic antennas.* <u>A twin line CMC may not be used to interconnect pieces of coax.</u>

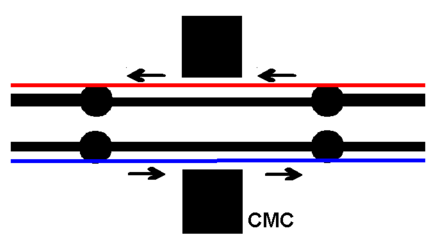


*Drawing 5*

In Drawing 6 two pieces of twin line are interconnected by a *coaxial* CMC. Common mode currents on both lines are blocked. The balance of both line pieces is not disturbed, and no feed line RF radiation occurs. <u>Two pieces of balanced feed line can safely be interconnected by a *coaxial* CMC.</u>


*Drawing 6*

In Drawing 7 two pieces of twin line are interconnected by a twin-line CMC. Common mode currents on both twin lines are still blocked. The balance of both line pieces is not disturbed, and no feed line RF radiation occurs. <u>Two pieces of balanced feed line can also be interconnected by a twin-line CMC.</u>



*Drawing 7*

## Conclusions :

a. A twin line CMC may NOT be inserted into a coaxial feedline.

b. In a coaxial feedline system only coaxial CMCs may be inserted.

c. Both twinline CMCs and coaxial CMCs can be inserted into a twinline feeding systems.

d. When a coaxial cable must be connected to a twinline, a *coaxial CMC* should be used.

e. When a coaxial cable is connected to a (balanced or dipole) antenna, a coaxial CMC ***must*** be inserted at the antenna feedpoint.