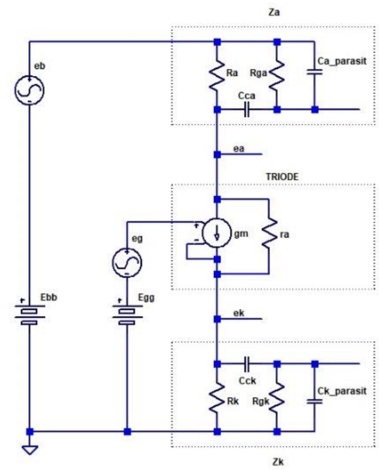
To develop models, start with a schematic of a generic Cathodyne:



Applying Kirchoff's Current Law to the AC signals at the a and k yields the following equations:

[1] $$\frac{ea-eb}{Za}+\frac{ea-ek}{ra}+gm*(eg-ek)=0$$

[2] $$\frac{ek}{Zk}+\frac{ek-ea}{ra}-gm*(eg-ek)=0$$

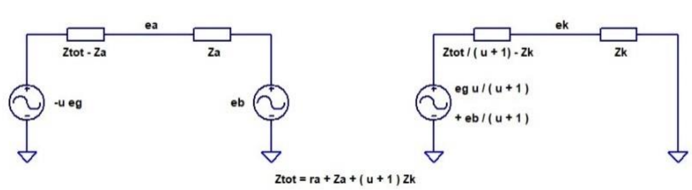
These can be solved for the a and k voltages ea and ek:

[3] $$ea=eb*\frac{Ztot-Za}{Ztot}-u*eg*\frac{Za}{Ztot}$$

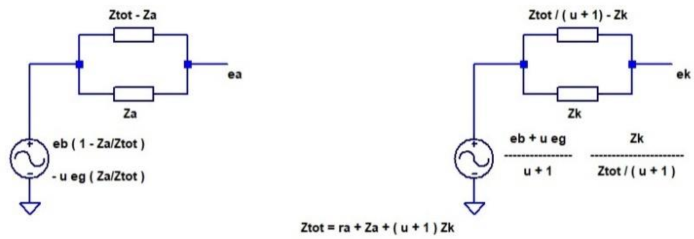
[4] $$ek=(u*eg+eb)*\frac{Zk}{Ztot}$$

Here, [5] $u=gm*ra$ and [6] $Ztot=ra+Za+(u+1)*Zk$.

Equations [3] and [4] describe circuits of their own:



The Thevenin equivalents (TE's) of these circuits can be written from inspection:



This pair of TEs comprises the Improved Model of the Cathodyne.

Equations [3] and [4] can also be used to develop the Thevenin Equivalent (TE) of a Traditional Model. The first step is to determine the TE open circuit voltage Eka_{oc}, the difference between the ek and ea voltages given in equations [4] and [3]:

[7] $$Eka_{oc} = \frac{Zk+Za}{Ztot} * u * eg - (\,1 - \frac{Zk+Za}{Ztot}) * eb$$

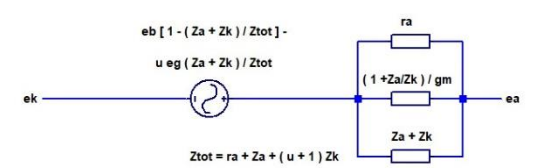
Next, the TE impedance is derived. A first step is to find the current Ika_{sc} which would flow through an AC-coupled short between the a and k, which is in parallel with ra. We can let ra serve as the short if we allow it to approach zero ohms. This means that Ika_{sc} = (Eka_{oc} / ra) as ra approaches zero. Using [5], [6] and [7] and simplifying:

[6] $$Ika_{sc} = \ gm * eg - \frac{1+gm*Zk}{Zk+Za} * eb$$

The TE impedance Zka = Eka_{oc} / Ika_{sc}, with further simplification, can be seen to be:

[7] $$Zka = \frac{1}{\frac{1}{ra}+\frac{gm}{1+\frac{Za}{Zk}}+\frac{1}{Za+Zk}}$$

Accordingly, this is the TE between the k and a:



I have not shown all the algebraic steps leading to each equation. To convince that equations [3] and [4] follow from [1] and [2], you could assign sets of random values to gm, ra, Za and Zk and evaluate [5] and [6], using the values and results to evaluate [3] and [4], and finally using the values and these results to confirm [1] and [2]. Alternatively, you could use those same sets of assigned random values with the LTSpice file attached to this post to compare simulations of the Cathodyne schematic to those of all the models discussed.