Multi-port element defined by Foster's canonical form — nportFoster

Form: `nportFoster:`⟨`instance name`⟩ n_1 n_2 $\cdots$ ⟨`parameter list`⟩
n_1, n_2 $\cdots$ are the element nodes.
Parameters:

Parameter	Type	Default value	Required?
filename: File containing the pole-residue data.	STRING	n/a	yes
ports: Number of ports	INTEGER	n/a	yes
poles1: Number of poles	INTEGER	n/a	yes
poles2: Number of poles	INTEGER	n/a	yes

Example:

```
fosternport: f1 1 "0" 2 "0" 3 "0" 4 "0" 5 "0" 6 "0"
filename = "testfosternport.yp" ports="6" poles1="36" poles2="36"
.ref "0"
```

DESCRIPTION:

- The element is implemented as a Linear Voltage Controlled Current Source
- The method followed for this implementation is the *"Pole – Residual"* method as it gives better numerical stability
- This is a N-Port generalization and so it would work for any number of ports and poles

TECHNICAL APPROACH :

- Each element in the multi – port Admittance matrix is described by its own rational function in the pole – residue format
- In this format different elements in the Admittance matrix may have different poles(meaning values for the poles)
- But all the elements in the Admittance matrix must have the same number of poles
- The representation made use of here is the Foster's Canonical representation
- Foster's Canonical representation is given as :

$$H(s) = \sum_{j=1}^{m} \frac{k_j}{s - p_j} + \left(\sum_{j=1}^{m} \frac{k_j}{s - b_j} + \frac{a_j^*}{s - b_j^*} \right)$$

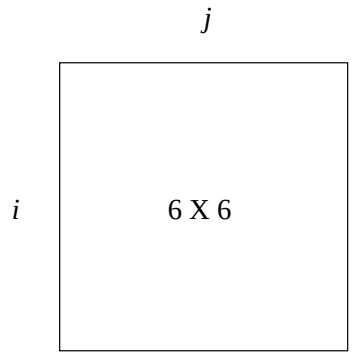
Here $k_j/(s - p_j)$ represents the real pole and $a_j/(s - b_j)$ plus $a_j/(s - b_j)$ together represents the complex conjugate pairs

- Frequency domain analysis is very straight forward as the given pole – residue data set is just plotted
- Time domain analysis involves complexity in the calculation of the Modified Nodal Admittance Matrix as it involves the derivatives

FILLING OF THE MODIFIED NODAL ADMITTANCE MATRIX :

- Number of ports and number of poles (also the data file set) are taken as the input parameters necessary for the netlist

- Suppose we have a 2 – port network, then we should have 4 instances of the given element(FosterNPort), that is, if Y(s) = [H_{11}(s) H_{12}(s) ; H_{21}(s) H_{22}(s)], then each H_{ii}(s) could be represented by this element
- In the data set, there is a real pole – residue expression and a complex pole – residue expression. The complex pole – residue expression is converted to real pole – residue format and then plugged in the matrix. In this way the element is created for each transfer function and connected in the circuitry.
- There is a function called the *"fillMNAM"* function which fills the modified nodal admittance matrix with the calculated transfer function values. A loop is put with respect to the *"fillMNAM"* function. For each iteration of the loop, the previous calculation is done and plugged for each 'element'
- Suppose if we have a 6 – port network then there can be any number of terminals between 7 and 12. In order to reduce the complexity of local reference nodes, we take half of the terminals as just one reference for all the ports. So here I have 7 terminals from 0 to 6, with the 6^{th} terminal taken as the reference
- In the frequency domain, the transfer function matrix is of the form :



- Each i[][] and j[][] contains 36 elements(as the given data set has 36*36 real

Poles and complex poles each)

- And each element in i[][] is represented by a setQuad function given by :

mnam -> setQuad (getTerminal(i)->getRC(),
getTerminal(ports)->getRC(),
getTerminal(j)->getRC(),
getTerminal(ports)->getRC(),g)
wherein each element has the Admittance matrix stamp which is [g -g; -g g]
REPRESENTATION OF FOSTER'S FORM IN THE NETLIST :
<filename>:<name of the element> <terminal numbers> <filename = > <ports = >
<poles = >
For example:
NPortFoster:f1 1 2 3 4 5 6 0 filename = 'transimtest.yp' ports = 6 poles = 36

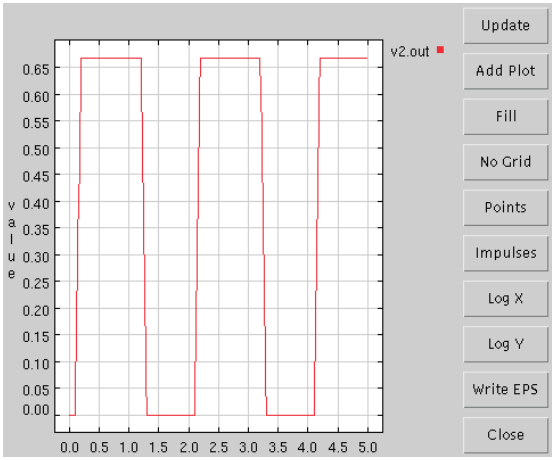
RESULTS :

1. **2 – Port network using 4 instances of the element:**

CIRCUIT :

Notes:
There is no equivalent SPICE element.

Version:
2002.06.01


v2.out
Update
Add Plot
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No Grid
Points
Impulses
Log X
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value
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
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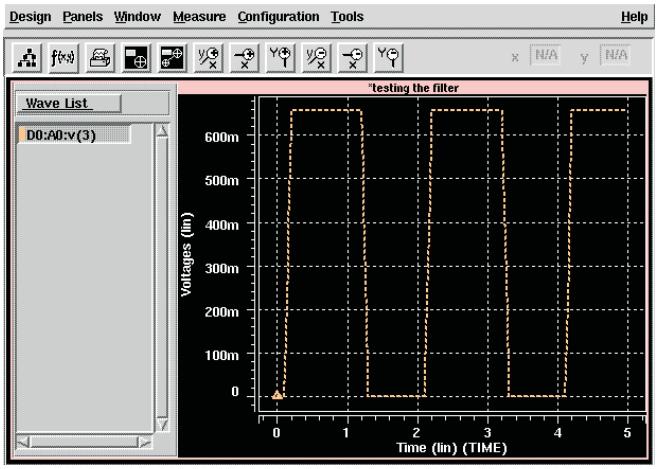
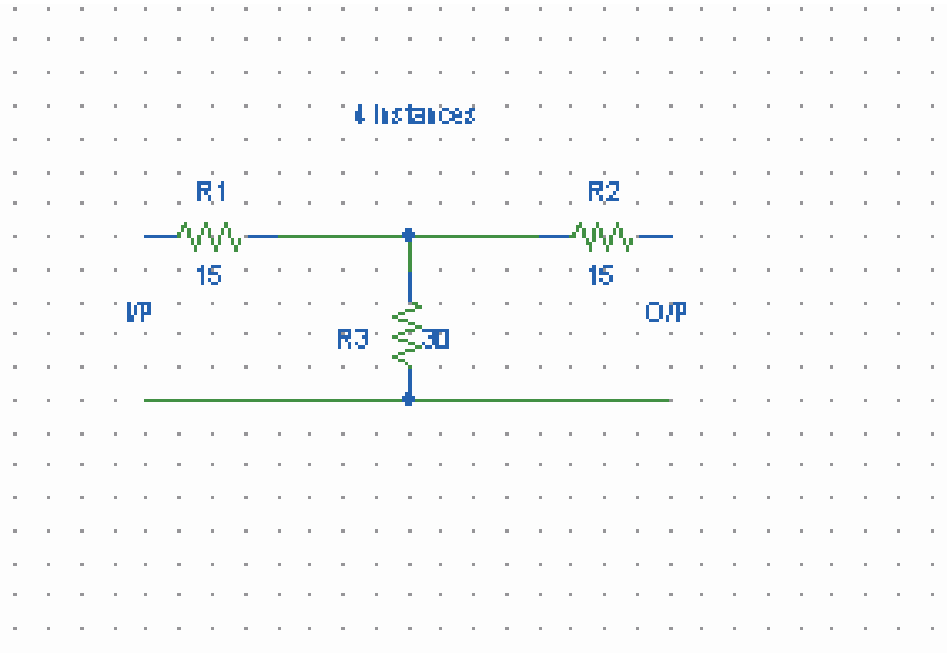
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0


Design Panels Window Measure Configuration Tools Help
Wave List
D0:A0:v(3)
*testing the filter
Voltages (lin)
600m
500m
400m
300m
200m
100m
0
0 1 2 3 4 5
Time (lin) (TIME)


4 Instances
R1
15
R2
15
I/P
O/P
R3
30

Credits:

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