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Distribution System Analysis Subcommittee

IEEE 4 Node Test Feeder

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 4 Node Test Feeder

The system to be use in testing transformer models is shown in Figure 1:
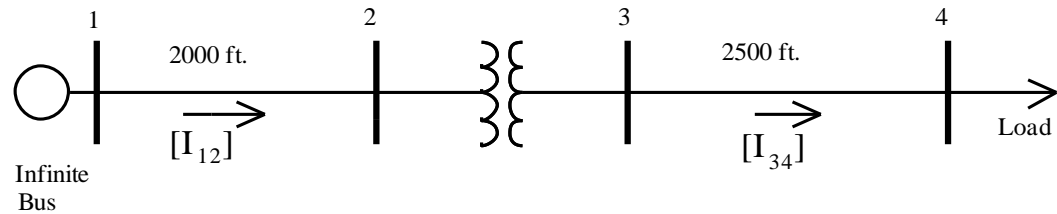

Figure 1 – IEEE 4 Node Test Feeder

Both the primary line (Node1-Node 2) and the secondary line (Node 3-node4) will be constructed using the pole configuration shown in Figure 2.
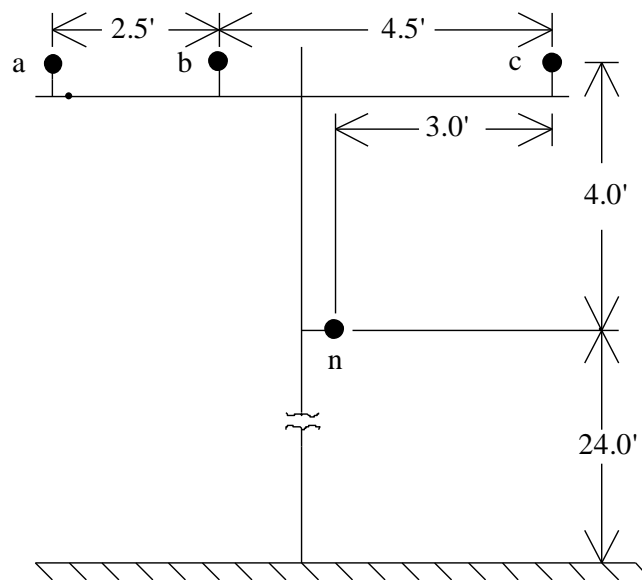

Figure 2 – Pole Configuration

Phase Conductor: 336,400 26/7
    GMR = 0.0244 ft., Resistance = 0.306 Ω/mile, Diameter = 0.721 inch

Neutral Conductor: 4/0 6/1 ACSR
    GMR = 0.00814 ft., Resistance = 0.592 Ω/mile, Diameter = 0.563 inch

The source is a 12.47 kV line-to-line infinite bus.

Three-Phase Transformer Data:

Connection	kVA	kVLL-high	kVLL-low	R - %	X - %
Step-Down	6,000	12.47	4.16	1.0	6.0
Step-Up	6,000	12.47	24.9	1.0	6.0

Open Wye – Open Delta:
(Two Single Phase Transformers Each Rated)

Connection	kVA	kV-high	kV-low	R - %	X - %
Step-Down	2000	7.2	4.16	1.0	6.0
Step-Up	2000	7.2	24.9	1.0	6.0

Closed Connections Load Data:

	Balanced	Unbalanced
Phase-1		
kW	1800	1275
Power Factor	0.9 lag	0.85 lag
Phase-2		
kW	1800	1800
Power Factor	0.9 lag	0.9 lag
Phase-3		
kW	1800	2375
Power Factor	0.9 lag	0.95 lag

Open Connection Load Data:

	Balanced	Unbalanced
Phase-1		
kW	1200	850
Power Factor	0.9 lag	0.85 lag
Phase-2		
kW	1200	1200
Power Factor	0.9 lag	0.9 lag
Phase-3		
kW	1200	1583.33
Power Factor	0.9 lag	0.95 lag

Loads are connected in grounded wye for four wire line configurations and connected in closed delta for three wire line configurations.

Line Impedances

4-wire configuration:

Phase impedance matrix:

$$zy = \begin{pmatrix} 0.4576 + 1.078j & 0.1559 + 0.5017j & 0.1535 + 0.3849j \\ 0.1559 + 0.5017j & 0.4666 + 1.0482j & 0.158 + 0.4236j \\ 0.1535 + 0.3849j & 0.158 + 0.4236j & 0.4615 + 1.0651j \end{pmatrix} \qquad \Omega/mile$$

Sequence impedances:

$$zy_{pos} = 0.3061 + 0.627j \qquad \Omega/mile$$

$$zy_{zero} = 0.7735 + 1.9373j \qquad \Omega/mile$$
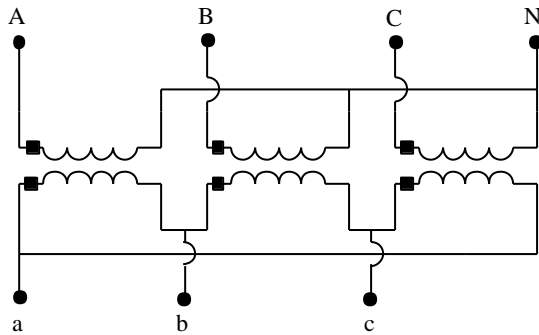
Three wire configuration:

Phase impedance matrix:

$$zd = \begin{pmatrix} 0.4013 + 1.4133j & 0.0953 + 0.8515j & 0.0953 + 0.7266j \\ 0.0953 + 0.8515j & 0.4013 + 1.4133j & 0.0953 + 0.7802j \\ 0.0953 + 0.7266j & 0.0953 + 0.7802j & 0.4013 + 1.4133j \end{pmatrix} \qquad \Omega/mile$$
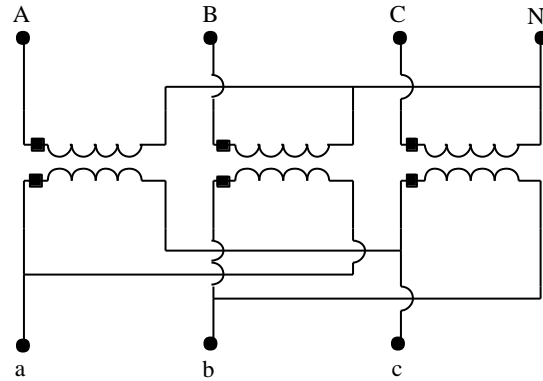
Sequence impedances:

$$zd_{pos} = 0.306 + 0.6272j \qquad \Omega/mile$$
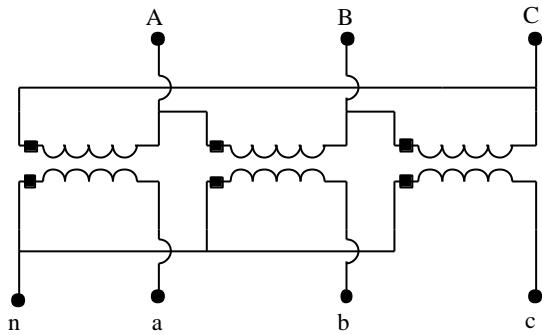
$$zd_{zero} = 0.5919 + 2.9855j \qquad \Omega/mile$$
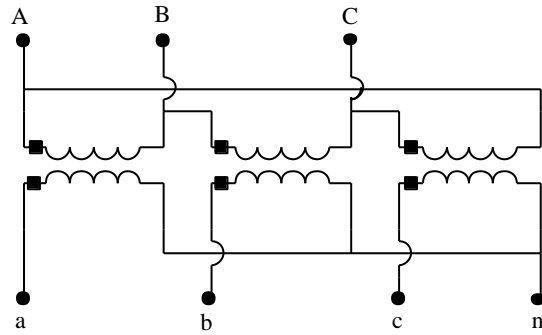
Standard Wye-Delta and Delta – Wye Connections
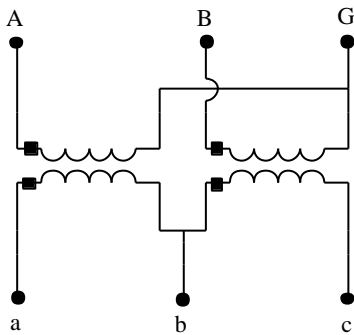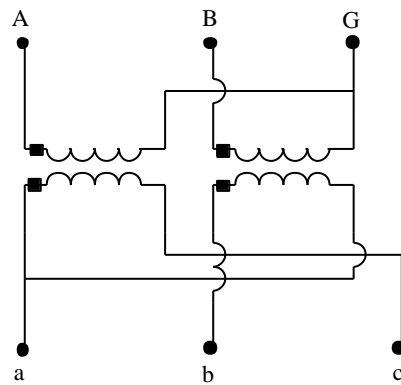
Wye-Delta Step Down

Wye – Delta Step Up

Delta – Wye Step Down

Delta - Wye Step Up

Open Wye-Delta Step Down

Open Wye-Delta Step Up

Solutions

Step-Down with Balanced Loading

Standard 30 degree connections are assumed for wye-delta and delta-wye banks

V1 = Vag for wye connections and Vab for delta connections
V2 = Vbg for wye connections and Vbc for delta connections
V3 = Vcg for wye connections and Vca for delta connections

Connection	Gr Y - Gr Y	Gr Y -D	Y - D	D - Gr Y	D - D	Open Gr.Y-D
Node-2						
V1	7107/-0.3	7113/-0.3	7112/-.03	12340/29.7	12339/29.7	6984/0.4
V2	7140/-120.3	7132/-120.3	7133/-120.4	12349/-90.4	12349/-90.4	7167/-121.7
V3	7121/119.6	7123/119.6	7124/119.6	12318/149.6	12321/149.6	7293/120.5
Node-3						
V1	2247.6/-3.7	3906/-3.5	3906/-3.4	2249/-33.7	3911/26.5	3701/-0.9
V2	2269/-123.5	3915/-123.6	3915/-123.6	2263/-153.4	3914/-93.6	4076/-126.5
V3	2256/116.4	3909/116.3	3909/116.3	2259/86.4	3905/146.4	3572/110.9
Node-4						
V1	1918/-9.1	3437/-7.8	3437/-7.8	1920/-39.1	3442/22.3	3384/-3.5
V2	2061/-128.3	3497/-129.3	3497/-129.3	2054/-158.3	3497/-99.4	3804.9/-130.2
V3	1981/110.9	3388/110.6	3388/110.6	1986/80.9	3384/140.7	3246/106.5
Current 1-2						
Ia	347.9/-34.9	334.8/-34.5	335.8/-34.7	335.0/-35.7	335.8/-34.7	380.9/-65.2
Ib	323.7/-154.2	335.4/-154.9	335.9/-154.6	331.8/-154.0	335.8/-154.6	387.4/-125.2
Ic	336.8/85.0	337.4/85.4	335.9/85.3	341.6/85.6	336.0/85.4	0
Current 3-4						
Ia	1042.8/-34.9	1006.6/-64.7	1006.6/-64.7	1041.9/-64.9	1006.7/-34.7	659.3/-65.2
Ib	970.2/-154.2	1006.7/175.4	1006.7/175.4	973.7/175.9	1006.7/-154.(	665.7/175.6
Ic	1009.6/85.0	1007.2/55.3	1007.2/55.3	1007.0/55.0	1007.2/85.4	670.5/54.8
Node 2						
Van			7116/-.03			
Vbn			7131/-120.3			
Vcn			7121/119.6			
Vng			3.6/169.5			

Step-Down with Unbalanced Loading

Standard 30 degree connections are assumed for wye-delta and delta-wye banks

V1 = Vag for wye connections and Vab for delta connections
V2 = Vbg for wye connections and Vbc for delta connections
V3 = Vcg for wye connections and Vca for delta connections

Connection	Gr Y - Gr Y	Gr Y -D	Y - D	D - Gr Y	D - D	Open Gr.Y-D
Node-2						
V1	7164/-0.1	7113/-0.2	7112/-0.2	12350/29.6	12341/29.8	6952/0.7
V2	7110/-120.2	7144/-120.4	7144/-120.4	12314/-90.4	12370/-90.5	7172/-122.0
V3	7082/119.3	7111/119.5	7112/119.5	12333/149.8	12302/149.5	7313/120.5
Node-3						
V1	2305/-2.3	3896/-2.8	3896/-2.8	2290/-32.4	3902/27.2	3632/0.1
V2	2255/-123.6	3972/-123.8	3972/-123.8	2261/-153.8	3972/-93.9	4121/-127.6
V3	2203/114.8	3875/115.7	3874/115.7	2214/85.2	3871/145.7	3450/108.9
Node-4						
V1	2175/-4.1	3425/-5.8	3425/-5.8	2157/-34.2	3431/24.3	3307/-1.5
V2	1930/-126.8	3646/-130.3	3646/-130.3	1936/-157.0	3647/-100.4	3907/-131.9
V3	1833/102.8	3298/108.6	3298/108.6	1849/73.4	3294/138.6	3073/103.1
Current 1-2						
Ia	230.1/-35.9	308.5/-41.5	309.8/-41.7	285.7/-27.6	361.7/-41.0	424.8/-73.8
Ib	345.7/-152.6	314.6/-145.5	315.5/-145.2	402.7/-149.6	283.5/-153.0	440.3/-118.5
Ic	455.1/84.7	389.0/85.9	387.2/85.9	349.1/74.4	366.5/93.2	0
Current 3-4						
Ia	689.7/-35.9	10083.8/-71.0	1083.8/-71.0	695.5/-66.0	1084/-41.0	735.2/-73.8
Ib	1036/-152.6	849.9/177.0	849.9/177.0	1033/177.1	849.7/-153.0	569.9/176.3
Ic	1364/84.7	1098.7/63.1	1098.7/63.1	1352/55.2	1099/93.2	762.0/61.5
Node 2						
Van			7116/-0.3			
Vbn			7142/-120.4			
Vcn			7109/119.6			
Vng			4.27/171.6			

IEEE

Step-Up with Balanced Loading

Standard 30 degree connections are assumed for wye-delta and delta-wye banks

V1 = Vag for wye connections and Vab for delta connections
V2 = Vbg for wye connections and Vbc for delta connections
V3 = Vcg for wye connections and Vca for delta connections

Connection	Gr Y - Gr Y	Gr Y -D	Y - D	D - Gr Y	D - D	Open Gr.Y-D
Node-2						
V1	7126/-0.3	7128/-0.3	7127/-0.3	12361/29.7	12361/29.7	7001/-0.3
V2	7145/-120.4	7145/-120.3	7145/-120.4	12372/-90.4	12372/-90.4	7183/-121.5
V3	7137/119.6	7137/119.6	7138/119.6	12348/149.6	12348/149.6	7281/120.5
Node-3						
V1	13675/-3.3	23746/56.7	23746/56.7	13697/26.7	23723/26.7	24603/54.1
V2	13715/-123.4	23722/-63.4	23722/-63.4	13710/-93.4	23746/-93.4	21938/-68.6
V3	13698/116.6	23698/176.7	23698/176.7	13681/146.6	23698/146.6	22433/178.7
Node-4						
V1	13631/-3.5	23680/56.6	23681/56.6	13653/26.6	23657/26.6	24558/54.0
V2	13682/-123.5	23663/-63.6	23664/-63.6	13678/-93.5	23688/-93.5	21900/-68.7
V3	13661/116.5	23625/176.5	23625/176.5	13644/146.5	23625/146.5	22380/178.6
Current 1-2						
Ia	293.0/-29.3	291.6/-29.1	292.4/-29.34	292.4/-29.3	292.4/-29.3	346.7/-61.3
Ib	291.9/-149.3	291.9/-149.6	292.4/-149.3	292.4/-149.3	292.4/-149.3	349.8/-121.4
Ic	292.3/90.6	293.7/90.7	292.4/90.7	292.4/90.7	292.4/90.7	0
Current 3-4						
Ia	146.7/-29.3	146.4/0.7	146.7/0-.7	146.5/0.7	146.4/-29.3	100.9/-0.9
Ib	146.2/-149.3	146.4/-119.3	146.4/-119.3	146.2/-119.4	146.4/-149.3	101.2/-121.4
Ic	146.4/90.6	146.4/120.7	146.4/120.7	146.6/120.6	146.4/90.7	100.2/118.7
Node 2						
Van			7130/-0.3			
Vbn			7144/-120.3			
Vcn			7136/119.6			
Vng			3.10/174.9			

Step-Up with Unbalanced Loading

Standard 30 degree connections are assumed for wye-delta and delta-wye banks

V1 = Vag for wye connections and Vab for delta connections
V2 = Vbg for wye connections and Vbc for delta connections
V3 = Vcg for wye connections and Vca for delta connections

Connection	Gr Y - Gr Y	Gr Y -D	Y - D	D - Gr Y	D - D	Open Gr.Y-D
Node-2						
V1	7161/-0.1	7121/-0.4	7120/-0.4	12364/29.8	12362/29.8	7001/0.01
V2	7120/-120.3	7147/-120.3	7147/-120.3	12391/-90.5	12392/-90.4	7207/-121.3
V3	7128/119.3	7150/119.5	7150/119.6	12333/149.6	12334/149.5	7264/120.5
Node-3						
V1	13839/-2.1	23703/57.2	23703/57.2	13792/27.7	23675/27.2	24762/55.0
V2	13663/-123.3	24040/-63.6	24040/-63.6	13733/-93.5	24060\-93.6	22756/-68.8
V3	13655/115.1	23576/176.1	23576/176.1	13641/145.4	23573/146.0	22455/177.6
Node-4						
V1	13815/-2.2	23637/57.1	23637/57.1	13768/27.7	23610/27.2	24716/54.9
V2	13614/-123.4	23995/-63.8	23995/-63.8	13684/-93.6	24015/-93.7	22728/-68.9
V3	13615/114.9	23496/175.9	23495/175.9	13600/145.2	23492/145.9	22398/177.5
Current 1-2						
Ia	216.8/-34.0	332.6/-28.1	333.5/-28.2	309.3/-35.2	312.3/-34.8	368.9/-52.6
Ib	293.3/-149.2	269.5/-155.6	269.6/-155.4	249.5/-146.5	248.1/-147.2	295.5/-119.5
Ic	366.7/96.7	275.5/100.3	274.3/100.2	319.3/98.1	316.5/98.7	0
Current 3-4						
Ia	108.6/-34.0	156.4/-4.8	156.4/-4.8	109.0/-4.1	156.4/-34.8	107.3/-5.6
Ib	147.0/-149.2	124.2/-117.2	124.2/117.2	146.2/-119.4	124.2/-147.2	85.4/-119.5
Ic	183.6/96.7	158.4/128.7	158.4/128.7	183.8/127.0	158.5/98.7	106.7/127.4
Node 2						
Van			7123/-0.3			
Vbn			7146/-120.2			
Vcn			7149/119.5			
Vng			2.79/-173.9			