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Distribution System Analysis Subcommittee

IEEE 4 Node Test Feeder



IEEE 4 Node Test Feeder

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

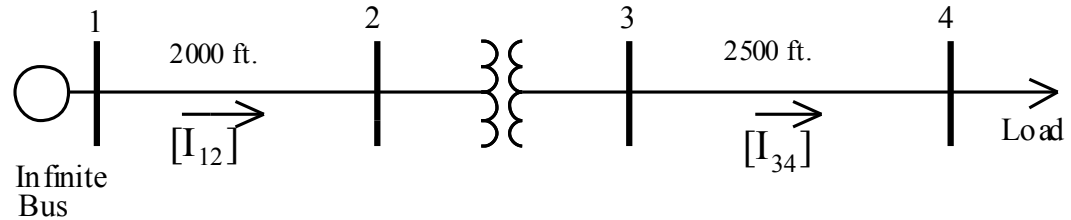


Figure 1 – IEEE 4 Node Test Feeder

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.

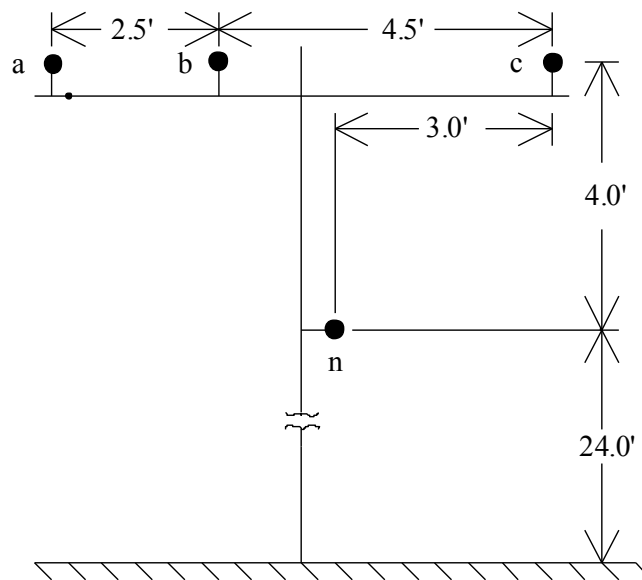


Figure 2 – Pole Configuration

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:

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

Sequence impedances:

$$z_{y_{\text{pos}}} = 0.3061 + 0.627j \quad \Omega/\text{mile}$$

$$z_{y_{\text{zero}}} = 0.7735 + 1.9373j \quad \Omega/\text{mile}$$

Three wire configuration:

Phase impedance matrix:

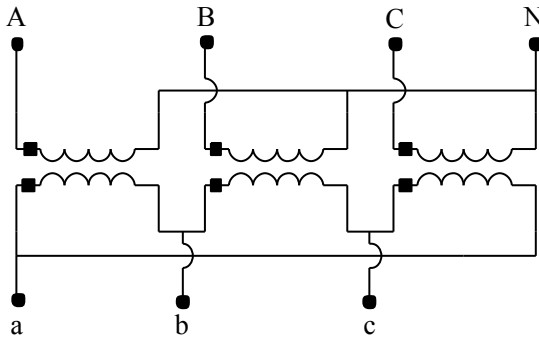
$$z_d = \begin{pmatrix} 0.4013 + 1.4133j & 0.0953 + 0.8515j & 0.0953 + 0.7266j \\ 0.0953 + 0.8515j & 0.4013 + 1.4133j & 0.0953 + 0.7802j \\ 0.0953 + 0.7266j & 0.0953 + 0.7802j & 0.4013 + 1.4133j \end{pmatrix} \quad \Omega/\text{mile}$$

Sequence impedances:

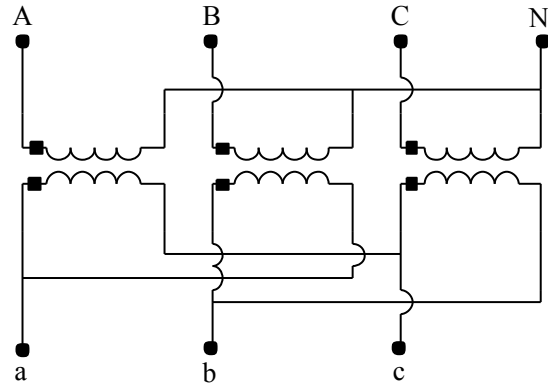
$$z_{d_{\text{pos}}} = 0.306 + 0.6272j \quad \Omega/\text{mile}$$

$$z_{d_{\text{zero}}} = 0.5919 + 2.9855j \quad \Omega/\text{mile}$$

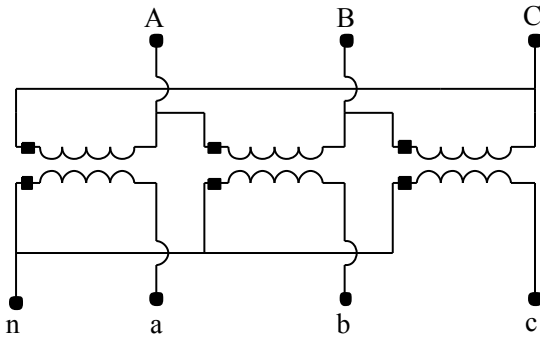
Standard Wye-Delta and Delta – Wye Connections



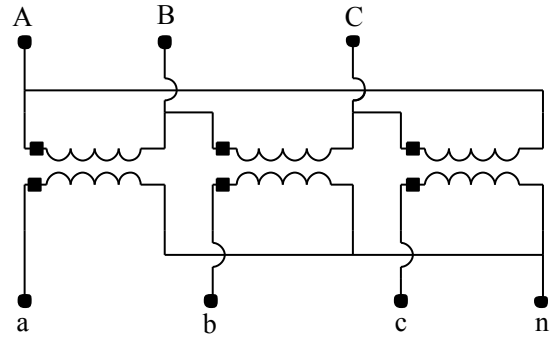
Wye-Delta Step Down



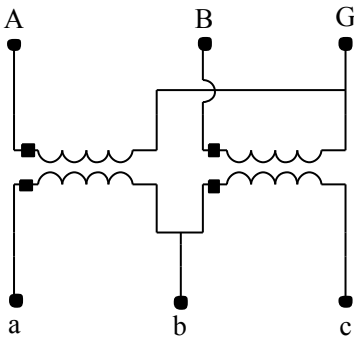
Wye – Delta Step Up



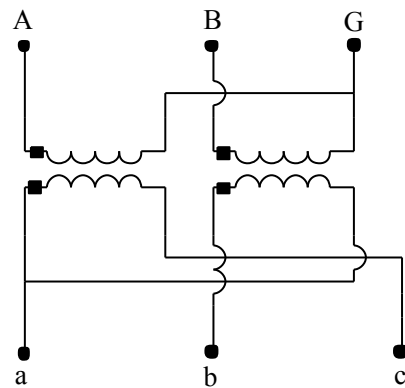
Delta – Wye Step Down



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/-0.3	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/-154.2	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/-0.3			
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			

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			