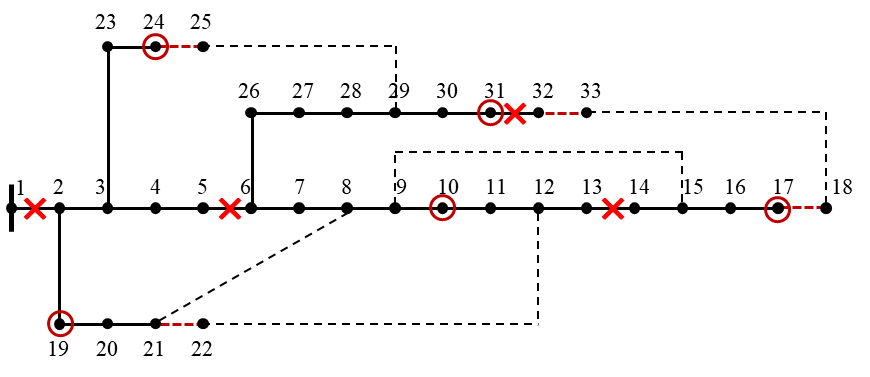


图**1** 改进的**IEEE** **14**节点配电系统结构图

**Fig.1 Modified IEEE 14-node power distribution system structure diagram**



图**2** 改进的**IEEE 33**节点配电系统结构图

**Fig.2 Modified IEEE 33-node power distribution system structure diagram**



图**3** 改进的**IEEE 69**节点配电系统结构图

**Fig.3 Modified IEEE 69-node power distribution system structure diagram**



图**4** 改进的**IEEE 123**节点配电系统结构图

**Fig.4 Modified IEEE 123-node power distribution system structure diagram**

表**A3** IEEE 14节点系统支路参数

**Table A3 Branch parameters of IEEE 14 node system**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 支路编号 | 始端节点 | 终端节点 | R (p.u.) | X (p.u.) | 支路编号 | 始端节点 | 终端节点 | R (p.u.) | X (p.u.) |
| 1 | 1 | 2 | 0.075 | 0.10 | 9 | 7 | 10 | 0.08 | 0.11 |
| 2 | 2 | 3 | 0.08 | 0.11 | 10 | 1 | 11 | 0.11 | 0.11 |
| 3 | 2 | 4 | 0.09 | 0.18 | 11 | 11 | 12 | 0.09 | 0.12 |
| 4 | 4 | 5 | 0.04 | 0.04 | 12 | 11 | 13 | 0.08 | 0.11 |
| 5 | 1 | 6 | 0.11 | 0.11 | 13 | 13 | 14 | 0.04 | 0.04 |
| 6 | 6 | 7 | 0.08 | 0.11 | 14 | 3 | 9 | 0.04 | 0.04 |
| 7 | 6 | 8 | 0.11 | 0.11 | 15 | 8 | 12 | 0.04 | 0.04 |
| 8 | 7 | 9 | 0.11 | 0.11 | 16 | 5 | 14 | 0.09 | 0.12 |

表**A4** IEEE 14节点系统节点负荷及重要度参数

**Table A4 Node power loads and weights parameters of IEEE 14 node system**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 节点编号 | P (MW) | Q (MVAR) | 负荷重要度 | 节点编号 | P (MW) | Q (MVAR) | 负荷重要度 |
| 1 | 0 | 0 | — | 8 | 1 | 0.9 | 1.6 |
| 2 | 2 | 1.6 | 1.8 | 9 | 0.6 | 0.5 | 1.8 |
| 3 | 3 | 0.4 | 1.8 | 10 | 4.5 | 1.7 | 1.8 |
| 4 | 2 | 0.4 | 1.8 | 11 | 1 | 0.9 | 1.8 |
| 5 | 1.5 | 1.2 | 3.0 | 12 | 1 | 1.1 | 1.6 |
| 6 | 4 | 2.7 | 2.0 | 13 | 1 | 0.9 | 2.0 |
| 7 | 5 | 1.8 | 2.0 | 14 | 2.1 | 0.8 | 2.0 |

表**A5** IEEE 14节点系统分布式电源参数

**Table A5 Distributed generation parameters of IEEE 14 node system**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 编号 | 安装节点 | Pmax(MW) | Pmin(MW) | Qmax(Mvar) | Qmin(Mvar) |
| 1 | 3 | 5 | 0 | 3 | -3 |
| 2 | 7 | 7 | 0 | 3 | -3 |
| 3 | 13 | 3 | 0 | 3 | -3 |

表**A6** IEEE 33节点系统支路参数

**Table A6 Branch parameters of IEEE 33 node system**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 支路编号 | 始端节点 | 终端节点 | R (Ω) | X (Ω) | 支路编号 | 始端节点 | 终端节点 | R (p.u.) | X (p.u.) |
| 1 | 1 | 2 | 0.0922 | 0.0470 | 20 | 20 | 21 | 0.4095 | 0.4784 |
| 2 | 2 | 3 | 0.4930 | 0.2511 | 21 | 21 | 22 | 0.7089 | 0.9373 |
| 3 | 3 | 4 | 0.3660 | 0.1864 | 22 | 3 | 23 | 0.4512 | 0.3083 |
| 4 | 4 | 5 | 0.3811 | 0.1941 | 23 | 23 | 24 | 0.8980 | 0.7091 |
| 5 | 5 | 6 | 0.8190 | 0.7070 | 24 | 24 | 25 | 0.8960 | 0.7011 |
| 6 | 6 | 7 | 0.1872 | 0.6188 | 25 | 6 | 26 | 0.2030 | 0.1034 |
| 7 | 7 | 8 | 0.7114 | 0.2351 | 26 | 26 | 27 | 0.2842 | 0.1447 |
| 8 | 8 | 9 | 1.0300 | 0.7400 | 27 | 27 | 28 | 1.0590 | 0.9337 |
| 9 | 9 | 10 | 1.0440 | 0.7400 | 28 | 28 | 29 | 0.8042 | 0.7006 |
| 10 | 10 | 11 | 0.1966 | 0.0650 | 29 | 29 | 30 | 0.5075 | 0.2585 |
| 11 | 11 | 12 | 0.3744 | 0.1238 | 30 | 30 | 31 | 0.9744 | 0.9630 |
| 12 | 12 | 13 | 1.4680 | 1.1550 | 31 | 31 | 32 | 0.3105 | 0.3619 |
| 13 | 13 | 14 | 0.5416 | 0.7129 | 32 | 32 | 33 | 0.3410 | 0.5302 |
| 14 | 14 | 15 | 0.5910 | 0.5260 | 33 | 8 | 21 | 0.5000 | 0.5000 |
| 15 | 15 | 16 | 0.7463 | 0.5450 | 34 | 9 | 15 | 0.5000 | 0.5000 |
| 16 | 16 | 17 | 1.2890 | 1.7210 | 35 | 12 | 22 | 0.5000 | 0.5000 |
| 17 | 17 | 18 | 0.3720 | 0.5740 | 36 | 18 | 33 | 0.5000 | 0.5000 |
| 18 | 2 | 19 | 0.1640 | 0.1565 | 37 | 25 | 29 | 0.5000 | 0.5000 |
| 19 | 19 | 20 | 1.5042 | 1.3554 |  |  |  |  |  |

表**A7** IEEE 33节点系统节点负荷及重要度参数

**Table A7 Node power loads and weights parameters of IEEE 33 node system**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 节点编号 | P (MW) | Q (MVAR) | 负荷重要度 | 节点编号 | P (MW) | Q (MVAR) | 负荷重要度 |
| 1 | 0 | 0 | — | 18 | 0.090 | 0.040 | 1.8 |
| 2 | 0.100 | 0.060 | 1.8 | 19 | 0.090 | 0.040 | 1.8 |
| 3 | 0.090 | 0.040 | 1.8 | 20 | 0.090 | 0.040 | 1.8 |
| 4 | 0.120 | 0.080 | 1.8 | 21 | 0.090 | 0.040 | 1.6 |
| 5 | 0.060 | 0.030 | 1.6 | 22 | 0.090 | 0.040 | 2.0 |
| 6 | 0.060 | 0.020 | 2.0 | 23 | 0.090 | 0.050 | 2.0 |
| 7 | 0.200 | 0.100 | 2.0 | 24 | 0.420 | 0.200 | 2.0 |
| 8 | 0.200 | 0.100 | 1.6 | 25 | 0.420 | 0.200 | 2.0 |
| 9 | 0.060 | 0.020 | 2.0 | 26 | 0.060 | 0.025 | 1.8 |
| 10 | 0.060 | 0.020 | 1.8 | 27 | 0.060 | 0.025 | 1.8 |
| 11 | 0.045 | 0.030 | 1.8 | 28 | 0.060 | 0.020 | 1.8 |
| 12 | 0.060 | 0.035 | 1.8 | 29 | 0.120 | 0.070 | 1.6 |
| 13 | 0.060 | 0.035 | 1.6 | 30 | 0.200 | 0.600 | 2.0 |
| 14 | 0.120 | 0.080 | 2.0 | 31 | 0.150 | 0.070 | 2.0 |
| 15 | 0.060 | 0.010 | 2.0 | 32 | 0.210 | 0.100 | 2.0 |
| 16 | 0.060 | 0.020 | 1.6 | 33 | 0.060 | 0.040 | 2.0 |
| 17 | 0.060 | 0.020 | 2.0 |  |  |  |  |

表**A8** IEEE 33节点系统分布式电源参数

**Table A8 Distributed generation parameters of IEEE 33 node system**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 编号 | 安装节点 | Pmax(MW) | Pmin(MW) | Qmax(Mvar) | Qmin(Mvar) |
| 1 | 10 | 0.5 | 0 | 0.3 | -0.3 |
| 2 | 17 | 0.5 | 0 | 0.3 | -0.3 |
| 3 | 19 | 0.5 | 0 | 0.3 | -0.3 |
| 4 | 24 | 0.5 | 0 | 0.2 | -0.2 |
| 5 | 31 | 0.3 | 0 | 0.2 | -0.2 |

表**A9** IEEE 69节点系统支路参数

**Table A9 Branch parameters of IEEE 69 node system**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | Head | Tail | R | X | Type |
| 0 | 0 | 1 | 0.0005 | 0.0012 | 0 |
| 1 | 1 | 2 | 0.0005 | 0.0012 | 0 |
| 2 | 2 | 3 | 0.0015 | 0.0036 | 0 |
| 3 | 3 | 4 | 0.0251 | 0.0294 | 0 |
| 4 | 4 | 5 | 0.3660 | 0.1864 | 0 |
| 5 | 5 | 6 | 0.3811 | 0.1941 | 0 |
| 6 | 6 | 7 | 0.0922 | 0.0470 | 0 |
| 7 | 7 | 8 | 0.0493 | 0.0251 | 0 |
| 8 | 8 | 9 | 0.8190 | 0.2707 | 0 |
| 9 | 9 | 10 | 0.1872 | 0.0619 | 0 |
| 10 | 10 | 11 | 0.7114 | 0.2351 | 0 |
| 11 | 11 | 12 | 1.0300 | 0.3400 | 0 |
| 12 | 12 | 13 | 1.0440 | 0.3450 | 0 |
| 13 | 13 | 14 | 1.0580 | 0.3496 | 0 |
| 14 | 14 | 15 | 0.1966 | 0.0650 | 0 |
| 15 | 15 | 16 | 0.3744 | 0.1238 | 0 |
| 16 | 16 | 17 | 0.0047 | 0.0016 | 0 |
| 17 | 17 | 18 | 0.3276 | 0.1083 | 0 |
| 18 | 18 | 19 | 0.2106 | 0.0696 | 0 |
| 19 | 19 | 20 | 0.3416 | 0.1129 | 0 |
| 20 | 20 | 21 | 0.0140 | 0.0046 | 0 |
| 21 | 21 | 22 | 0.1591 | 0.0526 | 0 |
| 22 | 22 | 23 | 0.3463 | 0.1145 | 0 |
| 23 | 23 | 24 | 0.7488 | 0.2475 | 0 |
| 24 | 24 | 25 | 0.3089 | 0.1021 | 0 |
| 25 | 25 | 26 | 0.1732 | 0.0572 | 0 |
| 26 | 1 | 27 | 0.0044 | 0.0108 | 0 |
| 27 | 27 | 28 | 0.0640 | 0.1565 | 0 |
| 28 | 28 | 29 | 0.3978 | 0.1315 | 0 |
| 29 | 29 | 30 | 0.0702 | 0.0232 | 0 |
| 30 | 30 | 31 | 0.3510 | 0.1160 | 0 |
| 31 | 31 | 32 | 0.8390 | 0.2816 | 0 |
| 32 | 32 | 33 | 1.7080 | 0.5646 | 0 |
| 33 | 33 | 34 | 1.4740 | 0.4873 | 0 |
| 34 | 3 | 35 | 0.0034 | 0.0084 | 0 |
| 35 | 35 | 36 | 0.0851 | 0.2083 | 0 |
| 36 | 36 | 37 | 0.2898 | 0.7091 | 0 |
| 37 | 37 | 38 | 0.0822 | 0.2011 | 0 |
| 38 | 7 | 39 | 0.0928 | 0.0473 | 0 |
| 39 | 39 | 40 | 0.3319 | 0.1114 | 0 |
| 40 | 8 | 41 | 0.1740 | 0.0886 | 0 |
| 41 | 41 | 42 | 0.2030 | 0.1034 | 0 |
| 42 | 42 | 43 | 0.2842 | 0.1447 | 0 |
| 43 | 43 | 44 | 0.2813 | 0.1433 | 0 |
| 44 | 44 | 45 | 1.5900 | 0.5337 | 0 |
| 45 | 45 | 46 | 0.7837 | 0.2630 | 0 |
| 46 | 46 | 47 | 0.3042 | 0.1006 | 0 |
| 47 | 47 | 48 | 0.3861 | 0.1172 | 0 |
| 48 | 48 | 49 | 0.5075 | 0.2585 | 0 |
| 49 | 49 | 50 | 0.0974 | 0.0496 | 0 |
| 50 | 50 | 51 | 0.1450 | 0.0738 | 0 |
| 51 | 51 | 52 | 0.7105 | 0.3619 | 0 |
| 52 | 52 | 53 | 1.0410 | 0.5302 | 0 |
| 53 | 10 | 54 | 0.2012 | 0.0611 | 0 |
| 54 | 54 | 55 | 0.0047 | 0.0014 | 0 |
| 55 | 11 | 56 | 0.7394 | 0.2444 | 0 |
| 56 | 56 | 57 | 0.0047 | 0.0016 | 0 |
| 57 | 2 | 58 | 0.0044 | 0.0108 | 0 |
| 58 | 58 | 59 | 0.0640 | 0.1565 | 0 |
| 59 | 59 | 60 | 0.1053 | 0.1230 | 0 |
| 60 | 60 | 61 | 0.0304 | 0.0355 | 0 |
| 61 | 61 | 62 | 0.0018 | 0.0021 | 0 |
| 62 | 62 | 63 | 0.7283 | 0.8509 | 0 |
| 63 | 63 | 64 | 0.3100 | 0.3623 | 0 |
| 64 | 64 | 65 | 0.0410 | 0.0478 | 0 |
| 65 | 65 | 66 | 0.0092 | 0.0116 | 0 |
| 66 | 66 | 67 | 0.1089 | 0.1373 | 0 |
| 67 | 67 | 68 | 0.0009 | 0.0012 | 0 |
| 68 | 34 | 65 | 0.0009 | 0.0012 | 1 |
| 69 | 7 | 38 | 0.0009 | 0.0012 | 2 |
| 70 | 26 | 53 | 0.0009 | 0.0012 | 3 |
| 71 | 19 | 68 | 0.0009 | 0.0012 | 4 |

表**A10** IEEE 69节点系统节点负荷

**Table A10 Node power loads parameters of IEEE 69 node system**

|  |  |  |
| --- | --- | --- |
| Number | P | Q |
| 0 | 0.000 | 0.000 |
| 1 | 0.000 | 0.000 |
| 2 | 0.000 | 0.000 |
| 3 | 0.000 | 0.000 |
| 4 | 0.000 | 0.000 |
| 5 | 0.003 | 0.002 |
| 6 | 0.040 | 0.030 |
| 7 | 0.075 | 0.054 |
| 8 | 0.030 | 0.022 |
| 9 | 0.028 | 0.019 |
| 10 | 0.145 | 0.104 |
| 11 | 0.145 | 0.104 |
| 12 | 0.008 | 0.006 |
| 13 | 0.008 | 0.006 |
| 14 | 0.000 | 0.000 |
| 15 | 0.046 | 0.030 |
| 16 | 0.060 | 0.035 |
| 17 | 0.060 | 0.035 |
| 18 | 0.000 | 0.000 |
| 19 | 0.001 | 0.001 |
| 20 | 0.114 | 0.081 |
| 21 | 0.005 | 0.004 |
| 22 | 0.000 | 0.000 |
| 23 | 0.028 | 0.020 |
| 24 | 0.000 | 0.000 |
| 25 | 0.014 | 0.010 |
| 26 | 0.014 | 0.010 |
| 27 | 0.026 | 0.019 |
| 28 | 0.026 | 0.019 |
| 29 | 0.000 | 0.000 |
| 30 | 0.000 | 0.000 |
| 31 | 0.000 | 0.000 |
| 32 | 0.014 | 0.010 |
| 33 | 0.020 | 0.014 |
| 34 | 0.006 | 0.004 |
| 35 | 0.000 | 0.000 |
| 36 | 0.079 | 0.056 |
| 37 | 0.385 | 0.275 |
| 38 | 0.385 | 0.275 |
| 39 | 0.041 | 0.028 |
| 40 | 0.004 | 0.003 |
| 41 | 0.004 | 0.004 |
| 42 | 0.026 | 0.019 |
| 43 | 0.024 | 0.017 |
| 44 | 0.000 | 0.000 |
| 45 | 0.000 | 0.000 |
| 46 | 0.000 | 0.000 |
| 47 | 0.100 | 0.072 |
| 48 | 0.000 | 0.000 |
| 49 | 1.244 | 0.888 |
| 50 | 0.032 | 0.023 |
| 51 | 0.000 | 0.000 |
| 52 | 0.227 | 0.162 |
| 53 | 0.059 | 0.042 |
| 54 | 0.018 | 0.013 |
| 55 | 0.018 | 0.013 |
| 56 | 0.028 | 0.020 |
| 57 | 0.028 | 0.020 |
| 58 | 0.026 | 0.019 |
| 59 | 0.026 | 0.019 |
| 60 | 0.000 | 0.000 |
| 61 | 0.024 | 0.017 |
| 62 | 0.024 | 0.017 |
| 63 | 0.001 | 0.001 |
| 64 | 0.000 | 0.000 |
| 65 | 0.006 | 0.004 |
| 66 | 0.000 | 0.000 |
| 67 | 0.039 | 0.026 |
| 68 | 0.039 | 0.026 |

表**11** IEEE 123节点系统支路参数

**Table 11 Branch parameters of IEEE 123 node system**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Number | Head | Tail | R | X | Type |
| 0 | 0 | 1 | 0.0025 | 0.0026 | 0 |
| 1 | 0 | 2 | 0.0036 | 0.0037 | 0 |
| 2 | 0 | 6 | 0.0015 | 0.0035 | 0 |
| 3 | 2 | 3 | 0.0029 | 0.0029 | 0 |
| 4 | 2 | 4 | 0.0047 | 0.0048 | 0 |
| 5 | 4 | 5 | 0.0036 | 0.0037 | 0 |
| 6 | 6 | 7 | 0.0010 | 0.0024 | 0 |
| 7 | 7 | 11 | 0.0033 | 0.0033 | 0 |
| 8 | 7 | 8 | 0.0033 | 0.0033 | 0 |
| 9 | 7 | 12 | 0.0015 | 0.0035 | 0 |
| 10 | 8 | 13 | 0.0062 | 0.0063 | 0 |
| 11 | 12 | 33 | 0.0022 | 0.0022 | 0 |
| 12 | 12 | 17 | 0.0042 | 0.0095 | 0 |
| 13 | 13 | 10 | 0.0036 | 0.0037 | 0 |
| 14 | 13 | 9 | 0.0036 | 0.0037 | 0 |
| 15 | 14 | 15 | 0.0055 | 0.0055 | 0 |
| 16 | 14 | 16 | 0.0051 | 0.0052 | 0 |
| 17 | 17 | 18 | 0.0036 | 0.0037 | 0 |
| 18 | 17 | 20 | 0.0015 | 0.0034 | 0 |
| 19 | 18 | 19 | 0.0047 | 0.0048 | 0 |
| 20 | 20 | 21 | 0.0076 | 0.0077 | 0 |
| 21 | 20 | 22 | 0.0013 | 0.0029 | 0 |
| 22 | 22 | 23 | 0.0080 | 0.0081 | 0 |
| 23 | 22 | 24 | 0.0014 | 0.0032 | 0 |
| 24 | 24 | 25 | 0.0018 | 0.0041 | 0 |
| 25 | 24 | 27 | 0.0010 | 0.0023 | 0 |
| 26 | 25 | 26 | 0.0014 | 0.0032 | 0 |
| 27 | 25 | 30 | 0.0033 | 0.0033 | 0 |
| 28 | 26 | 32 | 0.0073 | 0.0074 | 0 |
| 29 | 27 | 28 | 0.0015 | 0.0034 | 0 |
| 30 | 28 | 29 | 0.0018 | 0.0040 | 0 |
| 31 | 29 | 120 | 0.0018 | 0.0040 | 0 |
| 32 | 30 | 31 | 0.0044 | 0.0044 | 0 |
| 33 | 33 | 14 | 0.0015 | 0.0015 | 0 |
| 34 | 34 | 35 | 0.0033 | 0.0077 | 0 |
| 35 | 34 | 39 | 0.0013 | 0.0029 | 0 |
| 36 | 35 | 36 | 0.0044 | 0.0044 | 0 |
| 37 | 35 | 37 | 0.0036 | 0.0037 | 0 |
| 38 | 37 | 38 | 0.0047 | 0.0048 | 0 |
| 39 | 39 | 40 | 0.0047 | 0.0048 | 0 |
| 40 | 39 | 41 | 0.0013 | 0.0029 | 0 |
| 41 | 41 | 42 | 0.0073 | 0.0074 | 0 |
| 42 | 41 | 43 | 0.0010 | 0.0024 | 0 |
| 43 | 43 | 44 | 0.0029 | 0.0029 | 0 |
| 44 | 43 | 46 | 0.0013 | 0.0029 | 0 |
| 45 | 44 | 45 | 0.0044 | 0.0044 | 0 |
| 46 | 46 | 47 | 0.0008 | 0.0017 | 0 |
| 47 | 46 | 48 | 0.0013 | 0.0029 | 0 |
| 48 | 48 | 49 | 0.0013 | 0.0029 | 0 |
| 49 | 49 | 50 | 0.0013 | 0.0029 | 0 |
| 50 | 50 | 116 | 0.0013 | 0.0029 | 0 |
| 51 | 51 | 52 | 0.0010 | 0.0024 | 0 |
| 52 | 52 | 53 | 0.0006 | 0.0015 | 0 |
| 53 | 53 | 54 | 0.0014 | 0.0032 | 0 |
| 54 | 53 | 56 | 0.0018 | 0.0041 | 0 |
| 55 | 54 | 55 | 0.0014 | 0.0032 | 0 |
| 56 | 56 | 57 | 0.0036 | 0.0037 | 0 |
| 57 | 56 | 59 | 0.0038 | 0.0087 | 0 |
| 58 | 57 | 58 | 0.0036 | 0.0037 | 0 |
| 59 | 59 | 60 | 0.0042 | 0.0021 | 0 |
| 60 | 59 | 61 | 0.0042 | 0.0021 | 0 |
| 61 | 61 | 62 | 0.0029 | 0.0014 | 0 |
| 62 | 62 | 63 | 0.0058 | 0.0029 | 0 |
| 63 | 63 | 64 | 0.0071 | 0.0035 | 0 |
| 64 | 64 | 65 | 0.0054 | 0.0027 | 0 |
| 65 | 66 | 67 | 0.0029 | 0.0029 | 0 |
| 66 | 66 | 71 | 0.0014 | 0.0032 | 0 |
| 67 | 66 | 96 | 0.0013 | 0.0029 | 0 |
| 68 | 67 | 68 | 0.0040 | 0.0041 | 0 |
| 69 | 68 | 69 | 0.0047 | 0.0048 | 0 |
| 70 | 69 | 70 | 0.0040 | 0.0041 | 0 |
| 71 | 71 | 72 | 0.0040 | 0.0041 | 0 |
| 72 | 71 | 75 | 0.0010 | 0.0023 | 0 |
| 73 | 72 | 73 | 0.0051 | 0.0052 | 0 |
| 74 | 73 | 74 | 0.0058 | 0.0059 | 0 |
| 75 | 75 | 76 | 0.0020 | 0.0047 | 0 |
| 76 | 75 | 85 | 0.0035 | 0.0082 | 0 |
| 77 | 76 | 77 | 0.0005 | 0.0012 | 0 |
| 78 | 77 | 78 | 0.0011 | 0.0027 | 0 |
| 79 | 77 | 79 | 0.0024 | 0.0056 | 0 |
| 80 | 79 | 80 | 0.0024 | 0.0056 | 0 |
| 81 | 80 | 81 | 0.0013 | 0.0029 | 0 |
| 82 | 80 | 83 | 0.0098 | 0.0100 | 0 |
| 83 | 81 | 82 | 0.0013 | 0.0029 | 0 |
| 84 | 83 | 84 | 0.0069 | 0.0070 | 0 |
| 85 | 85 | 86 | 0.0023 | 0.0053 | 0 |
| 86 | 86 | 87 | 0.0025 | 0.0026 | 0 |
| 87 | 86 | 88 | 0.0014 | 0.0032 | 0 |
| 88 | 88 | 89 | 0.0033 | 0.0033 | 0 |
| 89 | 88 | 90 | 0.0011 | 0.0027 | 0 |
| 90 | 90 | 91 | 0.0044 | 0.0044 | 0 |
| 91 | 90 | 92 | 0.0011 | 0.0027 | 0 |
| 92 | 92 | 93 | 0.0040 | 0.0041 | 0 |
| 93 | 92 | 94 | 0.0015 | 0.0035 | 0 |
| 94 | 94 | 95 | 0.0029 | 0.0029 | 0 |
| 95 | 96 | 97 | 0.0014 | 0.0032 | 0 |
| 96 | 97 | 98 | 0.0028 | 0.0064 | 0 |
| 97 | 98 | 99 | 0.0015 | 0.0035 | 0 |
| 98 | 99 | 122 | 0.0015 | 0.0035 | 0 |
| 99 | 100 | 101 | 0.0033 | 0.0033 | 0 |
| 100 | 100 | 104 | 0.0014 | 0.0032 | 0 |
| 101 | 101 | 102 | 0.0047 | 0.0048 | 0 |
| 102 | 102 | 103 | 0.0102 | 0.0103 | 0 |
| 103 | 104 | 105 | 0.0033 | 0.0033 | 0 |
| 104 | 104 | 107 | 0.0016 | 0.0038 | 0 |
| 105 | 105 | 106 | 0.0084 | 0.0085 | 0 |
| 106 | 107 | 108 | 0.0065 | 0.0066 | 0 |
| 107 | 107 | 121 | 0.0065 | 0.0066 | 0 |
| 108 | 108 | 109 | 0.0044 | 0.0044 | 0 |
| 109 | 109 | 110 | 0.0084 | 0.0085 | 0 |
| 110 | 109 | 111 | 0.0018 | 0.0018 | 0 |
| 111 | 111 | 112 | 0.0076 | 0.0077 | 0 |
| 112 | 112 | 113 | 0.0047 | 0.0048 | 0 |
| 113 | 114 | 34 | 0.0019 | 0.0044 | 0 |
| 114 | 115 | 0 | 0.0020 | 0.0047 | 0 |
| 115 | 117 | 51 | 0.0020 | 0.0047 | 0 |
| 116 | 118 | 66 | 0.0018 | 0.0041 | 0 |
| 117 | 119 | 100 | 0.0013 | 0.0029 | 0 |
| 118 | 12 | 117 | 0.0013 | 0.0029 | 0 |
| 119 | 17 | 114 | 0.0013 | 0.0029 | 0 |
| 120 | 59 | 118 | 0.0013 | 0.0029 | 0 |
| 121 | 96 | 119 | 0.0013 | 0.0029 | 0 |
| 122 | 70 | 78 | 0.0013 | 0.0029 | 1 |
| 123 | 116 | 121 | 0.0013 | 0.0029 | 2 |
| 124 | 46 | 120 | 0.0013 | 0.0029 | 3 |
| 125 | 53 | 93 | 0.0013 | 0.0029 | 4 |
| 126 | 3 | 94 | 0.0013 | 0.0029 | 5 |

表**12** IEEE 123节点系统节点负荷

**Table 12 Node power loads parameters of IEEE 123 node system**

|  |  |  |
| --- | --- | --- |
| Number | P | Q |
| 0 | 0.040 | 0.020 |
| 1 | 0.020 | 0.010 |
| 2 | 0.000 | 0.000 |
| 3 | 0.040 | 0.020 |
| 4 | 0.020 | 0.010 |
| 5 | 0.040 | 0.020 |
| 6 | 0.020 | 0.010 |
| 7 | 0.000 | 0.000 |
| 8 | 0.040 | 0.020 |
| 9 | 0.020 | 0.010 |
| 10 | 0.040 | 0.020 |
| 11 | 0.020 | 0.010 |
| 12 | 0.000 | 0.000 |
| 13 | 0.000 | 0.000 |
| 14 | 0.000 | 0.000 |
| 15 | 0.040 | 0.020 |
| 16 | 0.020 | 0.010 |
| 17 | 0.000 | 0.000 |
| 18 | 0.040 | 0.020 |
| 19 | 0.040 | 0.020 |
| 20 | 0.000 | 0.000 |
| 21 | 0.040 | 0.020 |
| 22 | 0.000 | 0.000 |
| 23 | 0.040 | 0.020 |
| 24 | 0.000 | 0.000 |
| 25 | 0.000 | 0.000 |
| 26 | 0.000 | 0.000 |
| 27 | 0.040 | 0.020 |
| 28 | 0.040 | 0.020 |
| 29 | 0.040 | 0.020 |
| 30 | 0.020 | 0.010 |
| 31 | 0.020 | 0.010 |
| 32 | 0.040 | 0.020 |
| 33 | 0.040 | 0.020 |
| 34 | 0.040 | 0.020 |
| 35 | 0.000 | 0.000 |
| 36 | 0.040 | 0.020 |
| 37 | 0.020 | 0.010 |
| 38 | 0.020 | 0.010 |
| 39 | 0.000 | 0.000 |
| 40 | 0.020 | 0.010 |
| 41 | 0.020 | 0.010 |
| 42 | 0.040 | 0.020 |
| 43 | 0.000 | 0.000 |
| 44 | 0.020 | 0.010 |
| 45 | 0.020 | 0.010 |
| 46 | 0.105 | 0.075 |
| 47 | 0.210 | 0.150 |
| 48 | 0.140 | 0.095 |
| 49 | 0.040 | 0.020 |
| 50 | 0.020 | 0.010 |
| 51 | 0.040 | 0.020 |
| 52 | 0.040 | 0.020 |
| 53 | 0.000 | 0.000 |
| 54 | 0.020 | 0.010 |
| 55 | 0.020 | 0.010 |
| 56 | 0.000 | 0.000 |
| 57 | 0.020 | 0.010 |
| 58 | 0.020 | 0.010 |
| 59 | 0.020 | 0.010 |
| 60 | 0.020 | 0.010 |
| 61 | 0.040 | 0.020 |
| 62 | 0.040 | 0.020 |
| 63 | 0.075 | 0.035 |
| 64 | 0.140 | 0.100 |
| 65 | 0.075 | 0.035 |
| 66 | 0.000 | 0.000 |
| 67 | 0.020 | 0.010 |
| 68 | 0.040 | 0.020 |
| 69 | 0.020 | 0.010 |
| 70 | 0.040 | 0.020 |
| 71 | 0.000 | 0.000 |
| 72 | 0.040 | 0.020 |
| 73 | 0.040 | 0.020 |
| 74 | 0.040 | 0.020 |
| 75 | 0.245 | 0.180 |
| 76 | 0.040 | 0.020 |
| 77 | 0.000 | 0.000 |
| 78 | 0.040 | 0.020 |
| 79 | 0.040 | 0.020 |
| 80 | 0.000 | 0.000 |
| 81 | 0.040 | 0.020 |
| 82 | 0.020 | 0.010 |
| 83 | 0.020 | 0.010 |
| 84 | 0.040 | 0.020 |
| 85 | 0.020 | 0.010 |
| 86 | 0.040 | 0.020 |
| 87 | 0.040 | 0.020 |
| 88 | 0.000 | 0.000 |
| 89 | 0.040 | 0.020 |
| 90 | 0.000 | 0.000 |
| 91 | 0.040 | 0.020 |
| 92 | 0.000 | 0.000 |
| 93 | 0.040 | 0.020 |
| 94 | 0.020 | 0.010 |
| 95 | 0.020 | 0.010 |
| 96 | 0.000 | 0.000 |
| 97 | 0.040 | 0.020 |
| 98 | 0.040 | 0.020 |
| 99 | 0.040 | 0.020 |
| 100 | 0.000 | 0.000 |
| 101 | 0.020 | 0.010 |
| 102 | 0.040 | 0.020 |
| 103 | 0.040 | 0.020 |
| 104 | 0.000 | 0.000 |
| 105 | 0.040 | 0.020 |
| 106 | 0.040 | 0.020 |
| 107 | 0.000 | 0.000 |
| 108 | 0.040 | 0.020 |
| 109 | 0.000 | 0.000 |
| 110 | 0.020 | 0.010 |
| 111 | 0.020 | 0.010 |
| 112 | 0.040 | 0.020 |
| 113 | 0.000 | 0.000 |
| 114 | 0.020 | 0.010 |
| 115 | 0.020 | 0.010 |
| 116 | 0.020 | 0.010 |
| 117 | 0.020 | 0.010 |
| 118 | 0.020 | 0.010 |
| 119 | 0.040 | 0.020 |
| 120 | 0.040 | 0.020 |
| 121 | 0.040 | 0.020 |
| 122 | 0.040 | 0.020 |