

$$\Delta P_i = P_i - G_{ii}U_i^2 - \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)] = 0$$

$$\Delta Q_i = Q_i + B_{ii}U_i^2 - \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)] = 0 \quad i = 1, 2, \dots, N$$


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$$\frac{\partial \Delta P_i}{\partial \theta_i} = \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta P_i}{\partial \theta_k} = -U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)], \quad (i \neq k)$$

$$\frac{\partial \Delta P_i}{\partial U_i} = -2G_{ii}U_i - \sum_{\substack{k=1 \\ k \neq i}}^N U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta P_i}{\partial U_k} = -U_i [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)], \quad (i \neq k)$$

$$\frac{\partial \Delta Q_i}{\partial \theta_i} = -\sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta Q_i}{\partial \theta_k} = U_i U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)], \quad (i \neq k)$$

$$\frac{\partial \Delta Q_i}{\partial U_i} = 2B_{ii}U_i - \sum_{\substack{k=1 \\ k \neq i}}^N U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta Q_i}{\partial U_k} = -U_i [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)], \quad (i \neq k)$$


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$$\Delta P_i = P_i - G_{ii}U_i^2 - \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)] = 0$$

$$\Delta Q_i = Q_i + B_{ii}U_i^2 - \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)] = 0 \quad i = 1, 2, \dots, N$$


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$$\frac{\partial \Delta P_i}{\partial \theta_i} = \sum_{\substack{k=1 \\ k \neq i}}^N U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta P_i}{\partial \theta_k} = -U_i U_k [G_{ik} \sin(\theta_i - \theta_k) - B_{ik} \cos(\theta_i - \theta_k)], \quad (i \neq k)$$

$$\frac{\partial \Delta P_i}{\partial U_i} = -2G_{ii}U_i - \sum_{\substack{k=1 \\ k \neq i}}^N U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)]$$

$$\frac{\partial \Delta P_i}{\partial U_k} = -U_i [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)], \quad (i \neq k)$$

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$$\frac{\partial \Delta Q_i}{\partial \theta_k} = U_i U_k [G_{ik} \cos(\theta_i - \theta_k) + B_{ik} \sin(\theta_i - \theta_k)], \quad (i \neq k)$$

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