$$\frac{\delta Q'_{bD}}{\delta T} = \sqrt{4 q N_A \epsilon_{Si}} \cdot \frac{\delta \left| V_{fp}^{1/2} \right|}{\delta T}$$

$$\frac{\delta \left| V_{fp}^{1/2} \right|}{\delta T} = \frac{1}{2} \left| V_{fp}^{-1/2} \right| \cdot \frac{\delta V_{fp}}{\delta T}$$

$$= \frac{1}{2} \left| V_{fp} \right|^{-1/2} \cdot \frac{K}{q} \ln \frac{N_A}{n_i}$$

Multiply top and bottom by T

$$= \frac{1}{2T} \left| V_{fp} \right|^{1/2}$$

so:

$$\frac{\delta Q'_{bo}}{\delta T} = \overbrace{\sqrt{2 q N_A \epsilon_{Si} \left| -2 V_{fp} \right|}}^{Q'_{bo}} \cdot \frac{1}{2T}$$

$$= \frac{Q'_{bo}}{2T}$$