So for: Let's call it $\varepsilon = \varepsilon_r$

$$a = 1000\left(\frac{c}{\sqrt{b^2+c}-b} - 2b\right) \quad , \quad b = 1 \text{ and } c = 0.004004$$

$b \to b\varepsilon_r \quad , \quad c \to c\varepsilon_r$

$2b \to (2\varepsilon_r \cdot b\varepsilon_r)\varepsilon_r$

$2b\varepsilon_r^3$

$b^2 \to b\varepsilon_r^3 \quad , \quad b^2+c \to (b\varepsilon_r^3 + c\varepsilon_r)\varepsilon_r$

$= b\varepsilon_r^4 + c\varepsilon_r^2$

For simplicity let's assume $\sqrt{\cdot}$ is also a fundamental operation. Then:

$\sqrt{b^2+c} \to \sqrt{b\varepsilon_r^4 + c\varepsilon_r^2}\,\varepsilon_r$ and so on.

In the end we get:

$$a \to \varepsilon_r^4\, 1000\left(\frac{c\varepsilon_r^{\cancel{2}}}{\sqrt{b\varepsilon_r^4 + c\varepsilon_r^2}\,\cancel{\varepsilon_r}} - 2b\varepsilon_r^3\right)$$

So a worst case rounding error of $O(\varepsilon_r^7)$