Define the mantissa $m \in [0, 1)$ as a B_m bit number. The high order $B_m/2$ bits fit in a B_m bit register h, and the lower order $B_m/2$ bits fit in a B_m bit register l. The mantissa is

$$m = 2^{\left(\frac{B_m}{2}\right)} h + l. \tag{1}$$

The mantissa is assumed to be normal (i.e. the high order bit is set).

Because the mantissa is normal, we can drop the leading bit and assume

$$\hat{m} = 1 + 2m = 1 + 2^{\left(\frac{B_m}{2}+1\right)} h + 2l, \tag{2}$$

where $\hat{m} \in [2, 1)$.

The square is

$$(\hat{m})^2 = 1 + 2^{\left(\frac{B_m}{2}+2\right)} h + 2^2 l + 2^{\left(\frac{B_m}{2}+3\right)} hl + 2^{(B_m+2)} h^2 + 2^2 l^2. \tag{3}$$

The normal representation is

$$\text{Norm}\left((\hat{m})^2\right) = 2^{\left(\frac{B_m}{2}+1\right)} h + 2l + 2^{\left(\frac{B_m}{2}+2\right)} hl + 2^{(B_m+1)} h^2 + 2l^2. \tag{4}$$

If the 2nd highest order bit of h is set (i.e. $h \wedge (2^{(B_m/2)-1}) \neq 0$, where $\wedge$ represents bitwise logical and) then the square will result in number greater than 1, and thus requires division by 2 to reduce it to the range $[0, 1)$,

$$\text{Norm}\left((\hat{m})^2\right) = 2^{\left(\frac{B_m}{2}+1\right)} h + 2l + 2^{\left(\frac{B_m}{2}+2\right)} hl + 2^{(B_m+1)} h^2 + 2l^2. \tag{5}$$

$$\text{Adj}\left((\hat{m})^2\right) = (\hat{m})^2 \, 2^{-1} = 2^{-1} + 2^{\left(\frac{B_m}{2}+1\right)} h + 2^1 l + 2^{\left(\frac{B_m}{2}+2\right)} hl + 2^{(B_m+1)} h^2 + 2^1 l^2. \tag{6}$$

We can rewrite this

$$\text{Adj}\left((\hat{m})^2\right) = 2^{\left(\frac{B_m}{2}+2\right)} (2^{-\frac{B_m}{2}-3} + 2^{-1} h + 2^{-\frac{B_m}{2}-2} l + hl + 2^{(B_m/2-1)} h^2 + 2^{-\frac{B_m}{2}-1} l^2. \tag{7}$$