We can write T in its matrix representation, consisting of the entries T_{ij}. Similarly, h has its vector components h_j. Note that

$$|h|^2 = \sum_j (h_j)^2$$

Consider the quantity

$$M^2 = \max_i \sum_{j=1}^n (T_{ij})^2$$

Then, as matrix multiplication is

$$T(h) = \sum_j T_{ij} h_j$$

$$|T(h)|^2 = \sum_{i=1}^m \left((h_i)^2 \sum_{j=1}^n (T_{ij})^2 \right) \le \sum_{i=1}^m (h_i)^2 M^2 = M^2 |h|^2$$

$$|T(h)| \le M|h|$$