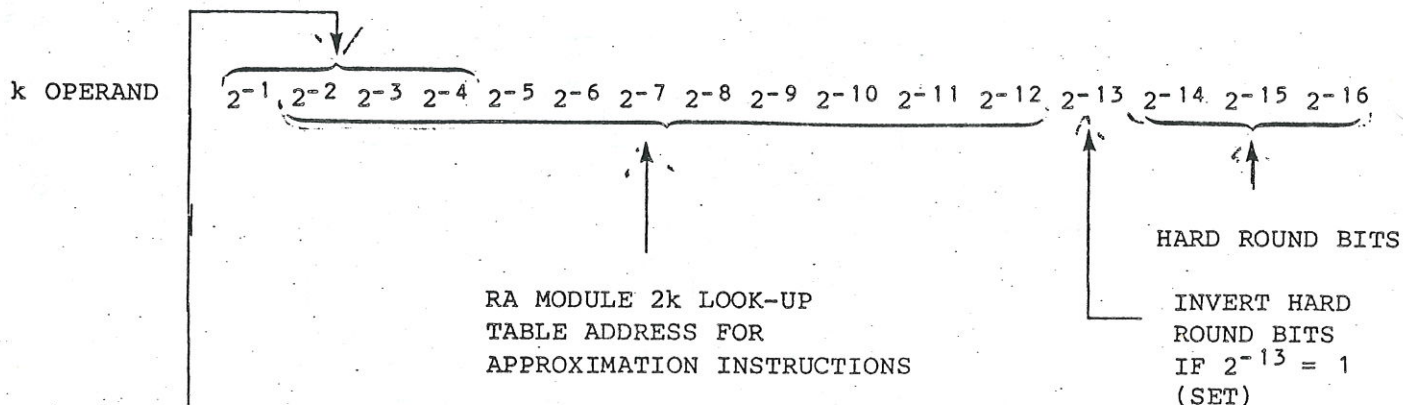## Reciprocal and Reciprocal Square Root Approximation Hard Round Bits

Three hard round bits are added to the coefficient multiply result, in the pyramid three bit add process, when doing a reciprocal or reciprocal square root approximation instruction. The incoming k operand determines the state of these hard round bits and the bit positions to which these bits will be added. The RA module handles the bits which determine the state and insertion point of the hard round bits. The MC and MD modules handle the pyramid bit positions that the hard round bits are added to. The ME module sends control to the RA to tell the RA that a reciprocal approximation or a reciprocal square root approximation instruction has issued. The RA determines the state and insertion point for the hard round bits. The RA sets the proper output terms to the MC and MD modules such that the hard round bits are added into the proper window during the three bit add process.

The ME module generates control terms for the reciprocal and reciprocal square root approximation instructions and sends it to the RA. The ME generates Gate Reciprocal Hard Round for the 132 and 166 instructions. The ME generates Gate Square Root Hard Round for the 133 and 167 instructions. The RA module looks at the k operand and determines what the state of the hard round bits should be and where to insert them into the pyramid addition process. The determination on the RA is as follows:

k OPERAND 2^{-1} 2^{-2} 2^{-3} 2^{-4} 2^{-5} 2^{-6} 2^{-7} 2^{-8} 2^{-9} 2^{-10} 2^{-11} 2^{-12} 2^{-13} 2^{-14} 2^{-15} 2^{-16}

RA MODULE 2k LOOK-UP
TABLE ADDRESS FOR
APPROXIMATION INSTRUCTIONS

HARD ROUND BITS

INVERT HARD
ROUND BITS
IF $2^{-13} = 1$
(SET)

THE UPPER FOUR BITS OF THE k
OPERAND SELECT THE INSERTION
POINT FOR THE THREE HARD
ROUND BITS INTO THE PYRAMID
ADD PROCESS.

The approximation instruction k operand is used to determine the state of the hard round bits and the insertion point. Bits 2^{-14}, 2^{-15}, and 2^{-16} are the hard round bits. Bit 2^{-13} determines if the hard round bits will be added on in their upright or inverted states. Bits 2^{-1} through 2^{-4} determine the insertion point bit positions for the hard round bits. The page of three tables demonstrates how the insertion point is determined.

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