CRAY-2 Floating Multiply Concepts (Square Root)

The CRAY-2 Floating Multiply Functional Unit provides the function of finding the approximate reciprocal square root of scalar or vector operands. This reciprocal square root can then be used to find the square root of a number.

A square root operation is performed in the CRAY-2 by multiplying an operand by the approximate reciprocal square root of that same operand. The square root sequence involves finding the approximate reciprocal square root of the operand and multiplying that result by the original operand. The sequence involves the use of the reciprocal square root approximation instructions and the multiply instructions.

Example: $16 = (1/\sqrt{16}) \times (16) = 4$

When performing a reciprocal square root approximation the CRAY-2 hardware accesses a look-up table to obtain values for use in the approximation process. The value from the look-up table is a predetermined value which never changes. The value read depends upon the operand. A portion of the operand is used to address the table to read this value out. The look-up value is substituted into parts of the equation that is used to calculate reciprocal square roots. The look-up value is derived from a guess at the actual result. The value reflects the result of substituting the guess into the part of the reciprocal square root equation that pertains to the look-up value. This guess comes in two parts from the table in a single 39-bit transfer. There is a 13-bit value which represents a number equal to three times the guess value divided by two. There is a 26-bit value which represents a number equal to negative the guess value cubed divided by two. The guess from the look-up table is very close. The guess is accurate to 13 binary places.

If a greater degree of accuracy is desired when finding the approximate reciprocal square root of an operand an iteration can be performed on the result of the reciprocal square root approximation instruction. A single iteration is allowed. The iteration process results in a correction factor which when multiplied by the original approximate reciprocal square root yields a more accurate approximate reciprocal square root.