NASA TECH BRIEF

Marshall Space Flight Center

Fast Carry Accumulator Design

A simple iterative accumulator was combined with gated-carry, carry-completion detection, and carry-skip circuits to produce three accumulators with decreased carry propagation times. These devices can be used in machine control, measurement equipment, and computer applications, to increase the speed of binary addition. NAND gates were used in the combining networks.

The average accumulation time was calculated using carry propagation lengths resulting from the accumulation of numbers with random bit distributions. The accumulation times, in order of highest to lowest, were: 6.50 μs for the iterative accumulator; 2.26 μs for the carry-completion detection accumulator; 2.14 μs for the gated-carry accumulator; and 1.24 μs for the carry-skip accumulator. If the dis-

Accumulator Design	t (μsec)	$(t/t_o) \times 100$	F	F/F_o	Q
Simple iterative accumulator	6.50	100	630	1	100
Gated-carry accumulator	2.14	33	756	1.2	40
Carry-completion detection accumulator	(Avg) 0.880	14	818	1.3	18
Carry-skip accumulator	1.24	19	816	1.3	25

Comparison of Accumulator Designs

All units offered a considerable decrease in accumulation time without a significant difference in cost between them and the iterative accumulator. The comparison was formalized by the following criterion (see table):

$$Q = (t/t_o)(F/F_o)\,100$$

Q = dimensionless cost comparison indicator
t = accumulation time of circuit
t_o = accumulation time of iterative accumulator
F = cost figure of circuit
F_o = cost figure of iterative accumulator

Based on the above, the carry-completion detection accumulator appears to be the most desirable, and would be recommended for use wherever a variable accumulation rate is acceptable. However, it should be noted that the control circuitry for this unit is more complex than that for other accumulators.

tribution is not random, the accumulation time for the carry-completion detection circuit could be greater than that for the carry-skip circuit.

The gated-carry circuit is applicable where fewer components are more desirable, and where the accumulation time obtained by this circuit is acceptable. It offers the fastest accumulation time for fixed-time operation. Where a fixed accumulation rate is desirable, the carry-skip circuit is recommended.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.95)

Reference:
NASA-TM-X-53983 (N70-29986), Fast Carry
Accumulator Design

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