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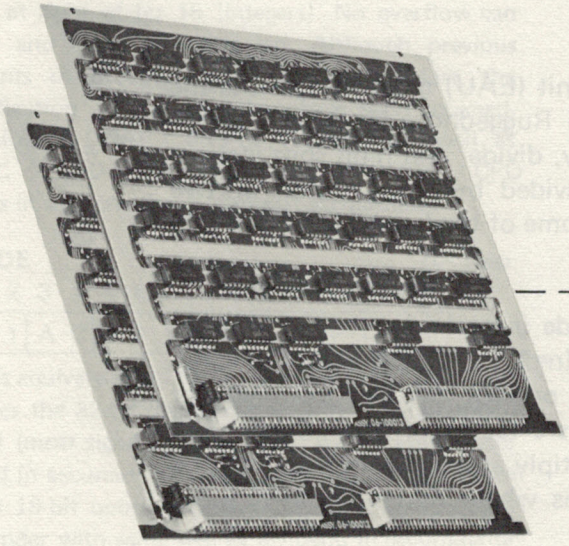
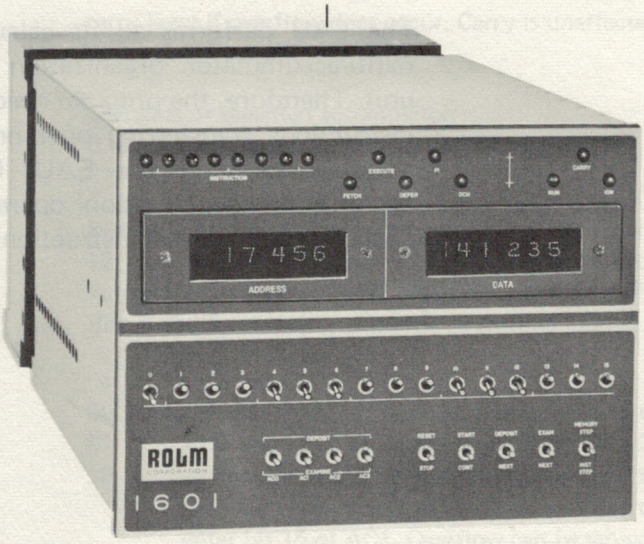
Extended Arithmetic Unit

Option /02





Model 1601 RUGGEDNOVA

FEATURES

The Extended Arithmetic Unit (EAU) greatly augments the capability of the Model 1601 Ruggednova by providing very high speed hardware multiply, divide, and n-bit shift instructions. This capability is provided by the addition of two circuit modules made up of some of the latest high speed MSI integrated circuits.

Hardware multiply and divide instructions require 9.7μseconds to execute. N-bit shift (n=1. . . . .16) is executed in 4.7 μseconds and can be right or left, circular, arithmetic,or logical shift. The EAU offers a factor of approximately 40 speedup in execution of multiply and divide instructions and is very useful in applications where numerous high speed computations are performed.

The availability of the EAU packaged on two circuit modules which plug into dedicated slots of the basic main frame provides easy installation even in the field. No back panel wiring or external wiring is required to accomplish the installation.

The EAU performs all its calculations within the existing multi-accumulator organization of the central processing unit. Therefore, the program need not execute any additional instructions transferring operands and results between the accumulators and the EAU. Multiply, divide and shift become single-instruction operations similar to the basic arithmetic and logical instructions.

MULTIPLY **9.7 μsec**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	A	C	0	1	0	1	0	1	1	1	1	1	1

This is equivalent to DOAC CPU

Performs 16-bit signed multiplication on contents of accumulator 1 and accumulator specified in bits 3 and 4; then stores 32-bit product in accumulators 0 and 1, with most significant half in 0. Scaling assumes radix at right of bit 15 (integers). No overflow can occur and carry is unaffected. Although previous contents of accumulators 0 and 1 are lost, the modification occurs after they have been accessed. Therefore, DOAC 0,CPU works as well as DOAC 2, CPU. The special case of DOAC 1,CPU results in squaring the contents of accumulator 1.

DIVIDE **9.7 μsec**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	A	C	0	1	0	1	1	1	1	1	1	1	1

This is equivalent to DOAP CPU

Divides the 32-bit dividend stored in accumulators 0 and 1 (most significant half in 0) by a 16-bit divisor stored in accumulator specified in bits 3 and 4; then stores 16-bit quotient in accumulator 1 and a 16-bit remainder with same sign as dividend in accumulator 0. Scaling assumes radix at right end of all operands and results (integers). Overflow occurs when relative magnitudes of divisor and dividend do not permit the quotient to be contained in 16 bits. This instruction unconditionally clears the carry bit if no overflow occurs or sets carry if overflow does occur. In the latter case, the contents of accumulators 0 and 1 are changed but are left containing garbage.

RIGHT SHIFT **4.7 μsec**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	A	C	0	1	0	0	0	1	1	1	1	1	1

This is equivalent to DOA CPU

Performs a right shift on the 32-bit contents of accumulators 0 and 1. The number of positions shifted and the type of shift (arithmetic, logical, or circular) are controlled by the contents of the accumulator specified in bits 3 and 4. No overflow can occur. Carry is unaffected.

Contents of specified accumulator:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								c				n			

Bits 0-7, 10 and 11 are ignored by the EAU. Bits 8 and 9, c, specify the type of shift as follows.

c

00, 01 — Circular shift: bit 15 of AC0 enters bit 0 of AC1 and bit 15 of AC1 enters bit 0 of AC0

10 — Arithmetic shift: bit 15 of AC0 enters bit 0 of AC1 but bit 15 of AC1 is lost. Sign (bit 0) of AC0 extends to the right.

11 — Logical shift: bit 15 of AC0 enters bit 0 of AC1 but bit 15 of AC1 is lost. Zeros enter bit 0 of AC0.

Bits 12-15, n, specify the number of bit positions shifted.

n

0000 — shift 16 positions

0001 ... 1111 — shift the specified number (1 to 15) of positions

LEFT SHIFT **4.7 μsec**

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	1	A	C	0	1	0	0	1	1	1	1	1	1	1

This is equivalent to DOAS CPU

Performs a left shift on the 32-bit contents of accumulators 0 and 1. The number of positions shifted and the type of shift (arithmetic, logical, or circular) are controlled by the contents of the accumulator specified in bits 3 and 4. No overflow can occur on logical or circular left shifts. On arithmetic left shifts, overflow occurs if the sign (bit 0 of ACO) changes any time during the operation. The carry bit is unconditionally cleared on an arithmetic left shift that causes no overflow, but carry is set if overflow does occur. Carry is unaffected by logical or circular left shifts.

Contents of specified accumulator:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
								c				n			

Bits 0-7, 10 and 11 are ignored by the EAU. Bits 12-15,n, specify the number of bit positions shifted in exactly the same manner described for right shift. Bits 8 and 9, c, specify the type of shift as follows:

c

00, 01 — Circular shift: bit 0 of AC1 enters bit 15 of AC0 and bit 0 of AC0 enters bit 15 of AC1

10 — Arithmetic shift: bit 0 of AC1 enters bit 15 of AC0, but bit 0 of AC0 is lost. Zeros enter bit 15 of AC1. Overflow can be sensed.

11 — Logical shift: exactly the same as arithmetic shift except no overflow sensing occurs.

SPECIFICATIONS

MULTIPLY
16-bit signed multiply with 32-bit product left in AC0 and AC1. Execution time 9.7 μseconds.

DIVIDE
Divides 32-bit dividend stored in AC0 and AC1 by 16-bit divisor stored in AC3 or AC4. Results in 16-bit quotient in AC1 and 16-bit remainder in AC0. Execution time 9.7 μseconds.

N-BIT SHIFT
(N=1,...,16) Right or left, circular, arithmetic, or logical shift, performed on the 32-bit contents of AC0 and AC1. Execution time 4.7 μseconds.

NET WEIGHT
2.1 lbs.

POWER REQUIREMENTS
+5 volts, 2 amps (adequately supplied by the main frame power supply)

THERMAL DISSIPATION
10 watts (circuit modules are conductively cooled to the ATR box side plate heat sinks)

EQUIPMENT SUPPLIED

The circuit modules are of the same type construction as the basic CPU modules. The modules are conductively cooled and contain the aluminum "cookie sheet" type stiffener. The modules have fork type connectors and plug into pre-installed female connectors in dedicated slots of the main frame. The EAU is known as Model 1601/02 and may be ordered with your Model 1601 Ruggednova or added at a later date.

For further information call or write:

ROLM CORPORATION

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