

- 1. IDENTIFICATION
- 1.1 Digital-8-10-U-Sym
- 1.2 Binary-Coded-Decimal to Binary Conversion Subroutine
- 1.3 March 1, 1965

2. ABSTRACT

A basic subroutine for converting binary-coded-decimal numbers to their equivalent binary value. Conversion is accomplished by "radix deflation."

3. REQUIREMENTS

3.1 Storage

This subroutine requires 23 (decimal) memory locations.

3.3 Equipment

Standard PDP-8.

4. USAGE

4.1 Loading

Load the subroutine with the Binary or RIM Loader.

4.2 Calling Sequence

Call with the number to be converted in the AC. Return will be to the location following the calling JMS with the result in the AC.

6. DESCRIPTION

6.1 Discussion

The method used is that of "radix deflation." Upon entry, the BCD number may be considered to be in the following form.

$$6.1.1.E \quad D_2 16^2 + D_1 16 + D_0$$

What is desired is the number in the form.

$$6.1.2.E \quad D_2 10^2 + D_1 10 + D_0$$

The PDP-8 can shift (rotate) and add. A right shift is equivalent to a division by a power of two. An appropriate series of shifts, additions, and subtractions is used to convert the number from the form of 6.1.1.E to that of 6.1.2.E.

6.2 Example

Consider the BCD number

0101 0001 1001

representing the decimal number 519.

First, the whole number is stored and then brought back into the AC. Next, the four most significant bits are masked out. At this point, the accumulator contains 16x16xA or

0101 0000 0000

A shift to the right of one bit yields

0010 1000 0000

This number is stored and then brought back to the AC, shifted right two bits, and the stored value added as follows

0000	1010	0000
0010	1000	0000
<u>0011</u>	<u>0010</u>	<u>0000</u>

Now the original number is added to this result

0011	0010	0000
0101	0001	1001
<u>1000</u>	<u>0011</u>	<u>1001</u>

and the most significant eight bits masked out as

1000 0011 0000

This is stored, brought back and shifted right once, and the stored value added.

0100	0001	1000
1000	0011	0000
<u>1100</u>	<u>0100</u>	<u>1000</u>

Next the result of this addition is shifted right two places dividing the number by four as follows

0011 0001 0010

negated and the original number added

1100	1110	1110
0101	0001	1001
<u>0010</u>	<u>0000</u>	<u>0111</u>

This result represents in binary 512 plus 4 plus 2 plus 1 or 519, the original number.

6.3 Scaling

This subroutine assumes an integral BCD number and yields an integral binary equivalent.

7. METHOD

7.2 Algorithm

The algorithm used is illustrated step by step in Section 10.4.

9. EXECUTION TIME

9.2 Maximum

The maximum (and invariant) execution time of this subroutine is 49.6 microseconds.

10. PROGRAM

10.4 Program Listing

A listing of the subroutine with BCDBIN located at 0200 is given below. To simplify mnemonics D_2 , D_1 , and D_0 have been replaced respectively with A, B, and C.

0200	0000	BCDBIN,	0	/ABC IN BCD CODE IN AC
0201	3223		DCA TEMPPP	
0202	1223		TAD TEMPPP	/16 (16A + B) + C
0203	0225		AND MASKKA	/16 (16A)
0204	7110		CLL RAR	/8 (16A)
0205	3224		DCA TEMPPQ	
0206	1224		TAD TEMPPQ	/8 (16A)
0207	7012		RTR	/2 (16A)
0210	1224		TAD TEMPPQ	/10 (16A)
0211	1223		TAD TEMPPP	/16 (26A + B) + C
0212	0226		AND MASKKB	/16 (26A + B)
0213	3224		DCA TEMPPQ	
0214	1224		TAD TEMPPQ	/16 (26A + B)
0215	7110		CLL RAR	/8 (26A + B)
0216	1224		TAD TEMPPQ	/24 (26A + B)
0217	7012		RTR	/6 (26A + B)
0220	7041		CIA	/-6 (26A + B)
0221	1223		TAD TEMPPP	/16 (16A + B) + C - 6 (26A + B) /= 16x16A - 6x26A + 16B - 6xB+C /= 100A + 10B + C
0222	5600		JMP I BCDBIN	/BINARY VALUE IN AC
0223	0000	TEMPPP;	0	
0224	0000	TEMPPQ,	0	
0225	7400	MASKKA,	7400	/MASK FOR MOST SIG. FOUR BITS
0226	7760	MASKKB,	7760	/MASK FOR MOST SIG. EIGHT BITS

12. REFERENCES

12.3 DECUS Programs

See DECUSCOPE January 1965, article entitled "Accelerated Radix Deflation on the PDP-7 and PDP-8."

14. ACKNOWLEDGEMENTS

Mr. Donald V. Weaver, Consultant, of New York City, who first described the algorithm used by this subroutine in reference 12.3 has granted his kind permission to include this subroutine in the PDP-8 library so that a detailed description may be available.

