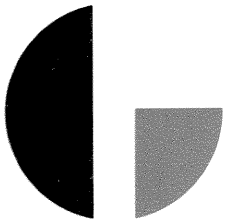

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PROGRAM

Gray Code to Binary

TAPES

ASCII Source: 090-000039

ABSTRACT

This routine converts a 16-bit Gray code number to its binary equivalent.

093-000035-00

1. REQUIREMENTS

1.1 Memory

1K or larger alterable memory

1.2 Equipment

NOVA central processor

1.3 External Subroutines

None

1.4 Other

None

2. OPERATING PROCEDURE

2.1 Calling Sequence

```
JSR  .GRYB
return
```

2.2 Input Format

A 16-bit Gray code word is passed in ACØ.

2.3 Output Format

The binary equivalent is returned in ACØ.

2.4 Error Returns

None

2.5 State of Active Registers upon Exit

AC1, AC2 are unchanged. ACØ, AC3, and Carry are destroyed.

2.6 Cautions to User

None

3. DISCUSSION

3.1 Algorithms

Let the Gray code number be represented by

$$G_n\ G_{n-1}\ \cdot\ \cdot\ \cdot\ G_1\ G_\emptyset$$

and the binary number as

$$B_n\ B_{n-1}\ \cdot\ \cdot\ \cdot\ B_1\ B_\emptyset$$

Then $$B_i = \sum_{j=i}^{n} G_j \bmod 2$$

Note that this is equivalent to

$$B_i = G_i \oplus B_{i+1} \qquad (i < n)$$

The latter formula is the principle of this routine. Each successive binary result is computed as the exclusive OR of the previous result bit and the present Gray code bit.

3.2 Limitations and Accuracy

The routine is exact for all 16-bit Gray code numbers.

3.3 Size and Timing

The routine is 22 (octal) words in length.

Execution time is 536.4 μ seconds.

3.4 References

Norman R. Scott, Analog and Digital Computer Technology, McGraw-Hill Book Company (1960), 237 - 239.

3.5 Flow Diagrams

None

4. EXAMPLES AND APPLICATIONS

For analog to digital conversion, it is desirable to use

a code which represents successive decimal digits with only one bit change. This is necessary since a smooth analog transition causes discrete digital changes. During a digital change, many erroneous codes might be transmitted if a weighted binary code were used. For example, the transition from Ø111 to 1ØØØ involves all four bits. Therefore, any code from ØØØØ through 1111 could be transmitted during the analog transition. Using an n-bit Gray code, the maximum error is only 1/2**n of the total range.

The ASCII source of .GRYB is provided with the NOVA software. If a user requires this routine, this tape should be edited into the user source.

5. PROGRAM LISTING

A listing of .GRYB follows. No origin is given in the source, enabling the user to edit this tape anywhere within his routine,

```
                ; GRAY CODE TO BINARY
                ; COMPUTES THE BINARY EQUIVALENT OF A 16 BIT GRAY CODE
                ; WORD

                ; INPUT:          GRAY CODE WORD IN AC0

                ; OUTPUT:         BINARY EQUIVALENT IN AC0

                ; CALLING SEQUENCE:
                ;       JSR      .GRYB
                ;       RETURN

                ; METHOD:         BIN(J) = SUM MOD 2 (N=0,J) GRAY(N)

                ; UNCHANGED:      AC1, AC2
                ; DESTROYED:      AC0, AC3, CARRY


00000 054017 .GRYB:   STA 3,.UC03      ; SAVE RETURN
00001 044016          STA 1,.UC01      ; *SAVE AC1
00002 024021          LDA 1,.UC20      ; ITERATION COUNT OF 16
00003 044020          STA 1,.UC10      ; SAVE IT
00004 126440          SUBO 1,1         ; CLEAR AC1, CARRY
00005 176660 .UC99:   SUBCR 3,3        ; CARRY TO AC3 BIT 0
00006 163120          ADDZL 3,0        ; SUM MOD 2
00007 125100          MOVL 1,1         ; RESULT BIT TO AC1
00010 135200          MOVR 1,3         ; GRAY BIT TO CARRY
00011 014020          DSZ .UC10        ; DONE?
00012 000005          JMP .UC99        ; NO
00013 121000          MOV 1,0          ; YES, MOVE RESULT TO AC0
00014 024016          LDA 1,.UC01      ; *RESTORE AC1
00015 002017          JMP @.UC03       ; RETURN


00016 000000 .UC01:   0                ; *SAVE AC1
00017 000000 .UC03:   0                ; SAVE RETURN

00020 000000 .UC10:   0                ; LOOP COUNT STORAGE
00021 000020 .UC20:   20               ; DECIMAL 16
```