DATA GENERAL CORPORATION

PROGRAM

Binary to Gray Code

TAPES

ASCII Source: 090-000038

ABSTRACT

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

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 .BGRY
   return

   2.2 Input Format

   A 16-bit binary word is passed in AC$\emptyset$.

   2.3 Output Format

   The Gray code equivalent is returned in AC$\emptyset$.

   2.4 Error Returns

   None.

   2.5 State of Active Registers upon Exit

   AC$\emptyset$, AC3, and Carry are destroyed. AC1 and AC2
   are unchanged.

   2.6 Cautions to User

   None.

3. DISCUSSION

3.1 Algorithms

Let the binary number be represented as

$$B_n \; B_{n-1} \cdot \cdot \cdot B_1 \; B_0$$

and the Gray code number as

$$G_n \; G_{n-1} \cdot \cdot \cdot G_1 \; G_0$$

Then $G_i = B_i \oplus B_{i+1}$ for $i < n$

and $G_n = B_n$ for $i = n$

Using 16-bit numbers, the algorithm simply reduces to

$$G = B \oplus (B/2)$$

where "B" is the input and "G" the output.

3.2 Limitations and Accuracy

The routine is exact for all 16-bit binary numbers.

3.3 Size and Timing

The routine is 13 (octal) words in length.

Execution time is $50.3 \; \mu$ 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 0111 to 1000 involves all four bits. Therefore,
any code from 0000 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 .BGRY is provided with the NOVA
software. If a user requires this routine, this
tape should be edited into the user's source.

5. PROGRAM LISTING

A listing of .BGRY follows. No origin is given in
the source, enabling the user to edit this tape any-
where within his routine.

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

; INPUT:          BINARY WORD IN AC0

; OUTPUT:         GRAY CODE WORD IN AC0

; CALLING SEQUENCE:
;         JSR     .BGRY
;           RETURN

; METHOD:         GRAY = BIN .XOR. (BIN/2)

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


00000 044011 .BGRY:  STA 1,.UB01       ; *SAVE AC1
00001 054012         STA 3,.UB03       ; SAVE RETURN
00002 105220         MOVZR 0,1         ; BIN/2
00003 135000         MOV 1,3           ; EXCLUSIVE OR (SEE .XOR )
00004 117520         ANDZL 0,3
00005 123000         ADD 1,0
00006 162400         SUB 3,0
00007 024011         LDA 1,.UB01       ; *RESTORE AC1
00010 002012         JMP @.UB03        ; RETURN


00011 000000 .UB01:  0                 ; *SAVE AC1
00012 000000 .UB03:  0                 ; SAVE RETURN
```