PROGRAM
PDP-7 Gray Code Conversion

COMPUTER SYSTEM
PDP-7 with special IOT instructions that permit the input of an encoded number in Gray binary.

DESCRIPTION
The Gray code is a specific n bit counting sequence of $2^n$ counts having the characteristics of being nonweighted, monostrophic (binary codes in which only one bit changes from count to count) and reflected (represents a numbering system of a radix $r$, and by complementing a given bit, which is the same bit for all counts and is usually the most significant bit, will yield the $r-1$'s complement of the original count) and represents a specific ordered numbering system of $2^n$ counts.

METHOD
Adjacent bits in the Gray word are compared. When they are equal, the corresponding normal bit is set to 0. When they are different, the corresponding normal bit is set to 1.

EXAMPLE
Gray binary input = 10100
Compute normal binary by comparing bits

<table>
<thead>
<tr>
<th>Gray</th>
<th>1</th>
<th>0</th>
<th>1</th>
<th>0</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Normal

SPECIFICATIONS

Timing
1. Size-oriented subroutine:
   $21 \mu \text{sec} + 12.25 \times N \mu \text{sec} + 8.75 \mu \text{sec}$
   average time = 210 $\mu$sec for 18-bit Gray code word

2. Speed-oriented subroutine:
   $7 \mu \text{sec} + 7 \times N \mu \text{sec} + 3.5K \mu \text{sec}$
   average time = 101.5 $\mu$sec for 18-bit Gray code word
   where $N$ is the number of Gray bits = 1
   where $K$ is the number of Gray bits = 0
Storage Requirements

1. Size-oriented subroutine
   14 locations

2. Speed-oriented subroutine
   \[ 3 + 31 \text{ locations} \]
   where \( I \) is the number of bits in the Gray code word

USAGE

The size-oriented routine is entered with the Gray code to be converted in the AC. The routine returns with the converted number (in normal binary) in the AC.

\[
\begin{align*}
\text{LAC} & \quad A \\
\text{JMS} & \quad \text{GRYBIN}
\end{align*}
\]

where \( A \) is the Gray code to be converted.

The speed-oriented routine is open coding, to be used when the number of Gray code bits to be converted is known.

Size-Oriented Conversion Routine Flow Chart
LISTING

Size-Oriented Routine

/GRAY CODE TO NORMAL BINARY - SIZE ORIENTED

GRYBIN, 0
DAC TEMP
LAC (11
DAC COUNT /INITIALIZE COUNTER FOR 12-BIT CONVERSION
LAC TEMP
CLL RAL /FIRST NORMAL BIT - FIRST GRAY BIT
SPL
XOR (400000
RAL /MOVE NORMAL BIT
ISZ COUNT /HAVE 12 BITS BEEN CONVERTED
JMP .-4 /NO - CONTINUE; LOOP
RAL /MOVE LAST NORMAL BIT
JMP I GRYBIN /RETURN

STORAGE MAP

TEMP (Gray number to be converted) C(TEMP)
COUNT Contains indexable constant for 12-bit conversion

SPEED-ORIENTED IN-LINE CODING

--- /MAIN PROGRAM
CLL RAL
SPL
XOR (400000
RAL
SPL
XDR (400000
RAL
. /REPEAT UNTIL I BITS HAVE
. /BEEN CONVERTED
RAL
--- /MAIN PROGRAM

DEFINITION OF TERMS

AC Accumulator
C(AC) Contents of AC
C(A) C(B) Contents of B are replaced by the contents of A
IOT Input-output transfer commands
## COMPARISON OF NUMBER SYSTEMS

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<thead>
<tr>
<th>Gray</th>
<th>Normal</th>
<th>Decimal</th>
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<tbody>
<tr>
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<td>1</td>
</tr>
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<td>2</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
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</tr>
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<td>1111</td>
<td>15</td>
</tr>
<tr>
<td>11000</td>
<td>10000</td>
<td>16</td>
</tr>
</tbody>
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