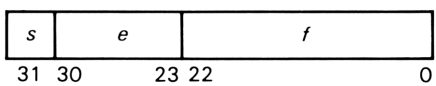
Appendix D

# Programs for Format Conversion

Different computing machines use various formats for representing numbers. Consequently, it is often necessary to convert numbers from one format to another. This appendix provides two programs to convert numbers between the proposed IEEE standard floating-point binary format and the floating-point decimal format used in the HP-16C. *

## Formats

The proposed IEEE single-precision, floating-point binary format is:




in a 32-bit format with
- 1-bit sign $s$,
- 8-bit biased exponent $e$, and
- 23-bit fraction $f$.

The value $v$ of a number $x$ (the contents of the X-register) is interpreted as follows:

(a) If $e = 255$ and $f \neq 0$, then $v = \text{NaN}$ (*not a number*).

(b) If $e = 255$ and $f = 0$, then $v = (-1)^s \infty$.

(c) If $0 < e < 255$, then $v = (-1)^s 2^{(e-127)} (1.f)$.

(d) If $e = 0$ and $f \neq 0$, then $v = (-1)^s 2^{(-126)} (0.f)$.

(e) If $e = 0$ and $f = 0$, then $v = (-1)^s 0$.

In Floating-Point Decimal mode on the HP-16C, the following conventions are used:

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*The standard for the floating-point binary format is a proposal of the IEEE Computer Society's Floating-Point Committee, Task 754. It has been set forth in *Computer*, March 1981, pages 51-62.

| IEEE Number | X-Register | Carry (Flag 4) | Out-of-Range (Flag 5) |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| −0 | 0 | 1 | 0 |
| ±∞ | $\pm 9.999999999 \times 10^{99}$ | 1 | 1 |
| Other Numbers | As defined above under (c) and (d) | 0 | 0 |
| Not a Number | $(-1)^s (0.f)\, 2^{23}$ | 1 | 0 |

**Program: Conversion from IEEE Format to HP-16C Format**

The following program converts a number from IEEE single-precision, floating-point binary format to floating-point decimal format.

| KEYSTROKES | DISPLAY | KEYSTROKES | DISPLAY |
|---|---|---|---|
| g LBL B | 001−43,22, b | x≷y | 018− 34 |
| HEX | 002− 23 | 8 | 019− 8 |
| f SET COMPL 2's | 003− 42 2 | f MASKL | 020− 42 7 |
| 2 | 004− 2 | g x=y | 021− 43 49 |
| 0 | 005− 0 | GTO 4 | 022− 22 4 |
| f WSIZE | 006− 42 44 | R↓ | 023− 33 |
| f SL | 007− 42 A | g x=0 | 024− 43 40 |
| ENTER | 008− 36 | GTO 3 | 025− 22 3 |
| ENTER | 009− 36 | x≷y | 026− 34 |
| g x=0 | 010− 43 40 | 1 | 027− 1 |
| GTO 2 | 011− 22 2 | 8 | 028− 8 |
| 1 | 012− 1 | f SB | 029− 42 4 |
| 8 | 013− 8 | g LBL 1 | 030−43,22, 1 |
| f MASKR | 014− 42 8 | g F? 4 | 031−43, 6, 4 |
| f AND | 015− 42 20 | CHS | 032− 49 |
| f XOR | 016− 42 10 | x≷y | 033− 34 |
| g LSTx | 017− 43 36 | 8 | 034− 8 |

| KEYSTROKES | DISPLAY | KEYSTROKES | DISPLAY |
|---|---|---|---|
| f RLn | 035- 42 E | g CLx | 051- 43 35 |
| 9 | 036- 9 | g x≠y | 052- 43 0 |
| 7 | 037- 7 | GTO 5 | 053- 22 5 |
| - | 038- 30 | 1 | 054- 1 |
| g CF 4 | 039-43, 5, 4 | 4 | 055- 4 |
| g LBL 2 | 040-43,22, 2 | 5 | 056- 5 |
| f FLOAT · | 041-42,45,48 | ENTER | 057- 36 |
| g RTN | 042- 43 21 | g LBL 5 | 058-43,22, 5 |
| g LBL 3 | 043-43,22, 3 | x⇄y | 059- 34 |
| 1 | 044- 1 | g F? 4 | 060-43, 6, 4 |
| 8 | 045- 8 | CHS | 061- 49 |
| f SB | 046- 42 4 | g ASR | 062- 43 b |
| x⇄y | 047- 34 | x⇄y | 063- 34 |
| GTO 1 | 048- 22 1 | g SF 4 | 064-43, 4, 4 |
| g LBL 4 | 049-43,22, 4 | GTO 2 | 065- 22 2 |
| R↓ | 050- 33 | | |

**Examples:**

| Keystrokes | Display | ( STATUS : 2-32-0000) |
|---|---|---|
| HEX 80000000 | 80000000 h | -0. |
| GSB B | 0.000000 00 | **C** set. |
| HEX 7F800000 | | $+\infty$. |
| GSB B | 9.999999 99 | **C** and **G** set. |
| HEX 00800000 | | $2^{-126} \times (1.00 \ldots 00)$. |
| GSB B | 1.175494-38 | |
| HEX 3F800001 | | $2^{0} \times (1.00 \ldots 01) = 1 + 2^{-23}$. |
| GSB B | 1.000000 00 | |
| f CLEAR PREFIX | 1000000119 | |

## Program: Conversion from HP-16C Format to IEEE Format

The following program converts a number from Decimal Floating-Point mode to IEEE single-precision floating-point binary format. Flag 5 (out-of-range) is set if $\pm\infty$ is the result. (The labels used in this program are different from those in program 1 so that both programs may be in memory at the same time.)

| KEYSTROKES | DISPLAY | KEYSTROKES | DISPLAY |
|---|---|---|---|
| g LBL A | 001-43,22, A | 0 | 025- 0 |
| f SET COMPL 2's | 002- 42 2 | f WSIZE | 026- 42 44 |
| HEX | 003- 23 | 8 | 027- 8 |
| g CF 4 | 004-43, 5, 4 | 0 | 028- 0 |
| g CF 5 | 005-43, 5, 5 | + | 029- 40 |
| g x=y | 006- 43 49 | 1 | 030- 1 |
| g RTN | 007- 43 21 | 8 | 031- 8 |
| 9 | 008- 9 | f MASKL | 032- 42 7 |
| D | 009- d | f AND | 033- 42 20 |
| + | 010- 40 | g F? 4 | 034-43, 6, 4 |
| x⇄y | 011- 34 | g ISZ | 035- 43 24 |
| g CF 0 | 012-43, 5, 0 | f SL | 036- 42 A |
| g x<0 | 013- 43 2 | RCL I | 037- 45 32 |
| g SF 0 | 014-43, 4, 0 | F | 038- F |
| g ABS | 015- 43 8 | F | 039- F |
| x⇄y | 016- 34 | g x>y | 040- 43 3 |
| g x<0 | 017- 43 2 | GTO 7 | 041- 22 7 |
| GTO 9 | 018- 22 9 | x⇄y | 042- 34 |
| 1 | 019- 1 | R↓ | 043- 33 |
| + | 020- 40 | R↓ | 044- 33 |
| g LBL 6 | 021-43,22, 6 | g CLx | 045- 43 35 |
| STO I | 022- 44 32 | g R↑ | 046- 43 33 |
| R↓ | 023- 33 | g R↑ | 047- 43 33 |
| 2 | 024- 2 | g SF 5 | 048-43, 4, 5 |

| KEYSTROKES | DISPLAY | KEYSTROKES | DISPLAY |
|---|---|---|---|
| g LBL 7 | 049-43,22, 7 | g LBL 9 | 062-43,22, 9 |
| R↓ | 050- 33 | g ABS | 063- 43 8 |
| f OR | 051- 42 40 | 3 | 064- 3 |
| g F? 0 | 052-43, 6, 0 | 0 | 065- 0 |
| GSB 8 | 053- 21 8 | g x≤y | 066- 43 1 |
| 9 | 054- 9 | x≷y | 067- 34 |
| f RRn | 055- 42 F | R↓ | 068- 33 |
| g CF 4 | 056-43, 5, 4 | 0 | 069- 0 |
| g RTN | 057- 43 21 | x≷y | 070- 34 |
| g LBL 8 | 058-43,22, 8 | f SB | 071- 42 4 |
| 8 | 059- 8 | ÷ | 072- 10 |
| f SB | 060- 42 4 | 0 | 073- 0 |
| g RTN | 061- 43 21 | GTO 6 | 074- 22 6 |

**Examples:**

| Keystrokes | Display | (STATUS: 2-32-0000) |
|---|---|---|
| f FLOAT · | | |
| 8 f EEX 72 | 8 72 | |
| GSB A | 7F800000 h | **G** set. Overflows to $+\infty$. |
| f FLOAT · | | |
| 1.404 f EEX | 1.404 00 | |
| 45 CHS | 1.404 -45 | |
| GSB A | 1 h | |
| f FLOAT · | | |
| 3.141592654 | 3.141592654 | $\pi$. |
| GSB A | 40490Fdb h | |