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LL                      II                  SS       SS
LL                      II                 SS      SS
LL                      II               SS     SS
LL                      II             SS    SS
LL                      II           SS   SS
LL                      II         SS  SS
LL                      II       SS SS
LL                      II     SS  SS
LL                      II   SS  SS
LLLLLLLLLLLLLLL          IIII            SSSSSSSS
LLLLLLLLLLLLLLL          IIII            SSSSSSSS

```


MTHSTANH
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L 2
; Floating Point Hyperbolic Tangent rout 16-SEP-1984 01:52:31 VAX/VMS Macro V04-00

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HISTORY : Detailed Current Edit History
DECLARATIONS : Declarative Part of Module
MTHSTANH - Standard Single Precision Floating TANH

MTH\$TANH
1-009

M 2
; Floating Point Hyperbolic Tangent rout 16-SEP-1984 01:52:31 VAX/VMS Macro V04-00
6-SEP-1984 11:27:23 [MTHRTL.SRC]MTH\$TANH.MAR;1

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```
0000 1 .TITLE MTH$TANH ; Floating Point Hyperbolic Tangent routine
0000 2 ; (TANH)
0000 3 .IDENT /1-009/ ; File: MTH$TANH.MAR Edit: JCW1009
0000 4 :
0000 5 :*****
0000 6 :*
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0000 23 :* SOFTWARE ON EQUIPMENT WHICH IS NOT SUPPLIED BY DIGITAL.
0000 24 :*
0000 25 :*
0000 26 :*****
0000 27 :
0000 28 :
0000 29 : FACILITY: MATH LIBRARY
0000 30 :++
0000 31 : ABSTRACT:
0000 32 :
0000 33 : MTH$TANH is a function which returns the floating point hyperbolic tangent
0000 34 : of its single precision floating point argument. The call is standard
0000 35 : call-by-reference.
0000 36 :
0000 37 :--
0000 38 :
0000 39 : VERSION: 01
0000 40 :
0000 41 : HISTORY:
0000 42 : AUTHOR:
0000 43 : Peter Yuo, 29-Jun-77: Version 01
0000 44 :
0000 45 : MODIFIED BY:
0000 46 :
0000 47 :
0000 48 :
```



```
0000 50      .SBTTL HISTORY ; Detailed Current Edit History
0000 51
0000 52
0000 53 : ALGORITHMIC DIFFERENCES FROM FP-11/C ROUTINE: none
0000 54 :
0000 55 : Edit History for Version 01 of MTH$TANH
0000 56 :
0000 57 : 0-4 - Call MTH$COSH, MTH$SINH directly instead of using POLY. TNH 13-June-78
0000 58 : 0-5 - Declare externals, word offsets. TNH 13-June-78
0000 59 : 1-006 - Put version number in standard format, with three digits of
0000 60 : edit number, and update copyright notice. JBS 16-NOV-78
0000 61 : 1-007 - Add " " to the PSECT directive. JBS 22-DEC-78
0000 62 : 1-008 - Change constant 16.0 to 10.0 for improved efficiency. The
0000 63 : value of X above which 1.0 is the best machine approximation
0000 64 : to TANH(X) is about 9.01. The next higher number that can be
0000 65 : represented as a short literal is 10.0. JAW 19-Sep-80
0000 66 : 1-009 - Changed the constant 2^-14 to 2^-12 to correct inaccuracy. For
0000 67 : values of |X| between 2^-14 and 2^-12 no noticeable loss of
0000 68 : significance was noticed by the assumption that TANH(x)=x starting
0000 69 : at |X|<=2^-14 instead of 2^-12, but a loss of performance was felt
0000 70 : do to an unnecessary computation of SINH(X)/COSH(X). All appropriate
0000 71 : references to 2^-14 have been changed to 2^-12. JCW 10-Jan-83
0000 72
```

```
0000 74 .SBTTL DECLARATIONS ; Declarative Part of Module
0000 75
0000 76 ;
0000 77 ; INCLUDE FILES: OTSPARAMS.MAR
0000 78 ;
0000 79 ; EXTERNAL SYMBOLS: MTH$JACKET_HDLR
0000 80 ;
0000 81 .DSABL GBL ; Force all symbols to need .EXTERN
0000 82 .EXTRN MTH$EXP R4 ; EXP
0000 83 .EXTRN MTH$COSH ; COSH
0000 84 .EXTRN MTH$SINH ; SINH
0000 85 ; EQUATED SYMBOLS:
0000 86
00003F80 0000 87 LF_0.25 = 0@16 + ^X3F80 ; 0.25
00003A80 0000 88 LF_2_POWER_M12 = 0@16 + ^X3A80 ; 2**-12
00004080 0000 89 SF_1.0 = ^F1.0 ; 1.0
00004220 0000 90 SF_10.0 = ^F10.0 ; 10.0
00000004 0000 91 value = 4 ; value.rf.r
0000 92
0000 93 ;
0000 94 ; MACROS: none
0000 95 ;
0000 96 ; PSECT DECLARATIONS:
0000 97
00000000 0000 98 .PSECT _MTH$CODE PIC,SHR,LONG,EXE,NOWRT
0000 99 ; program section for math routines
0000 100 ;
0000 101 ; OWN STORAGE: none
0000 102 ;
0000 103 ;
0000 104 ; CONSTANTS:
0000 105 ;
0000 106 ; NONE
```



```
0000 108 .SBTTL MTH$TANH - Standard Single Precision Floating TANH
0000 109
0000 110
0000 111 :++
0000 112 : FUNCTIONAL DESCRIPTION:
0000 113 :
0000 114 : TANH - single precision floating point function
0000 115 :
0000 116 : TANH(X) is computed as:
0000 117 :
0000 118 : If |X| <= 2**(-12), then TANH(X) = X.
0000 119 : If 2**(-12) < |X| <= 0.25, then TANH(X) = SINH(X)/COSH(X).
0000 120 : If 0.25 < |X| < 10.0, then TANH(X) = (EXP(2*X) - 1) / (EXP(2*X) + 1)
0000 121 : If 10.0 <= |X|, then TANH(X) = sign(X) * 1
0000 122 :
0000 123 : CALLING SEQUENCE:
0000 124 :
0000 125 : TANH.wf.v = MTH$TANH(x.rf.r)
0000 126 :
0000 127 : INPUT PARAMETERS:
0000 128 :
00000004 0000 129 : LONG = 4 ; define longword multiplier
00000004 0000 130 : x = 1 * LONG ; Contents of x is the argument
0000 131 :
0000 132 : IMPLICIT INPUTS: none
0000 133 :
0000 134 : OUTPUT PARAMETERS:
0000 135 :
0000 136 : VALUE: floating hyperbolic tangent of the argument
0000 137 :
0000 138 : IMPLICIT OUTPUTS: none
0000 139 :
0000 140 : COMPLETION CODES: none
0000 141 :
0000 142 : SIDE EFFECTS: none
0000 143 :
0000 144 : NOTE: This procedure disables floating point underflow, enables integer
0000 145 : overflow.
0000 146 :
0000 147 : ---
0000 148 :
0000 149 :
401C 0000 150 : .ENTRY MTH$TANH, ^M<IV, R2, R3, R4>
0002 151 : ; standard call-by-reference entry
0002 152 : ; disable DV (and FU), enable IV
0002 153 : MTH$FLAG_JACKET ; flag that this is a jacket procedure in
0002 :
6D 00000000'GF 9E 0002 : MOVAB G^MTH$$JACKET_HND, (FP)
0009 : ; set handler address to jacket
0009 : handler
0009 :
0009 154 : ; case of an error in routine
0009 155 : ; If an error, convert signal to user PC
0009 156 : ; and resignal
0009 157 : MOVF @value(AP), R0 ; R0 = |X| = @value(AP)
50 04 BC 50 0009 157 : BICW #^X8000, R0 ; R0 = |X|
50 8000 8F AA 000D 158 : CMPF R0, #LF_2_POWER_M12 ; compare |X| with 2**(-12)
00003A80 8F 50 51 0012 159
```

```

46 15 0019 160 BLEQ OUT_X ; branch if |X| <= 2**(-12)
      001B 161
      001B 162
      001B 163 ; 2**(-12) < |X|
      001B 164
      001B 165
22 50 51 001B 166 CMPF R0, S^#SF_10.0 ; compare |X| with 10.0
35 18 001E 167 BGEQ GEQ_TO_10.0 ; branch if |X| >= 10.0
      0020 168
      0020 169 ; 2**(-12) < |X| < 10.0
      0020 170
      0020 171
      0020 172
00003F80 8F 50 51 0020 173 CMPF R0, #LF_0.25 ; compare |X| with 0.25
17 15 0027 174 BLEQ LEQ_TO_0.25 ; branch if |X| <= 0.25
      0029 175
      0029 176
      0029 177 ; 0.25 < |X| < 10.0
      0029 178
      0029 179
50 04 BC 04 BC 41 0029 180 ADDF3 @value(AP), @value(AP), R0
      002F 181 ; R0 = 2*X
      002F 182 JSB G^MTH$EXP_R4 ; R0 = EXP(2*X)
      51 50 08 41 0035 183 ADDF3 S^#SF_1.0, R0, R1 ; R1 = EXP(2*X) + 1
      50 08 42 0039 184 SUBF S^#SF_1.0, R0 ; R0 = EXP(2*X) - 1
      50 51 46 003C 185 DIVF R1, R0 ; R0 = (EXP(2*X) - 1) / (EXP(2*X) + 1)
      04 003F 186 RET ; return with result in R0
      0040 187
      0040 188
      0040 189 ; 2**(-12) < |X| <= 0.25
      0040 190
      0040 191
      0040 192 LEQ_TO_0.25:
00000000'GF 6C FA 0040 193 CALLG (AP), G^MTH$COSH ; R0 = COSH(X)
52 50 50 0047 194 MOVF R0, R2 ; R2 = COSH(X)
00000000'GF 6C FA 004A 195 CALLG (AP), G^MTH$SINH ; R0 = SINH(X)
50 52 46 0051 196 DIVF R2, R0 ; R0 = SINH(X) / COSH(X)
      04 0054 197 RET ; return with result in R0
      0055 198
      0055 199
      0055 200 ; |X| >= 10.0
      0055 201
      0055 202
      0055 203 GEQ_TO_10.0:
50 08 50 0055 204 MOVF S^#SF_1.0, R0 ; R0 = 1.0
      04 BC 53 0058 205 TSTF @value(AP) ; test the sign of X
      18 005B 206 BGEQ 10$ ; branch if X >= 0
50 50 52 005D 207 MNEGF R0, R0 ; R0 = -1
      04 0060 208 10$: RET ; return with result in R0
      0061 209
      0061 210
      0061 211 ; |X| <= 2**(-12)
      0061 212
      0061 213
50 04 BC 50 0061 214 OUT_X: MOVF @value(AP), R0 ; R0 = TANH(X) = X
      04 0065 215 RET ; return with result in R0
      0066 216
```


MTHTANH
1-009

E 3
: Floating Point Hyperbolic Tangent rout 16-SEP-1984 01:52:31 VAX/VMS Macro V04-00
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0066 217
0066 218
0066 219

.END

MTH\$TANH
Symbol table

F 3
; Floating Point Hyperbolic Tangent rout 16-SEP-1984 01:52:31 VAX/VMS Macro V04-00
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GEQ_TO_10.0 00000055 R 01
LEG_TO_0.25 00000040 R 01
LF_0.25 = 00003F80
LF_2_POWER_M12 = 00003A80
LONG = 00000004
MTH\$JACKET_HND ***** X 01
MTH\$COSH ***** X 00
MTH\$EXP_R4 ***** X 00
MTH\$SINH ***** X 00
MTH\$TANH 00000000 RG 01
OUT_X 00000061 R 01
SF_T.0 = 00004080
SF_10.0 = 00004220
VALUE = 00000004

! Psect synopsis !

PSECT name	Allocation	PSECT No.	Attributes
ABS	00000000 (0.)	00 (0.)	NOPIC USR
MTH\$CODE	00000066 (102.)	01 (1.)	PIC USR

CON ABS LCL NOSHR NOEXE NORD NOWRT NOVEC BYTE
CON REL LCL SHR EXE RD NOWRT NOVEC LONG

! Performance indicators !

Phase	Page faults	CPU Time	Elapsed Time
Initialization	29	00:00:00.10	00:00:01.48
Command processing	119	00:00:00.69	00:00:03.92
Pass 1	86	00:00:00.73	00:00:04.03
Symbol table sort	0	00:00:00.01	00:00:00.00
Pass 2	53	00:00:00.55	00:00:03.08
Symbol table output	3	00:00:00.02	00:00:00.02
Psect synopsis output	2	00:00:00.02	00:00:00.02
Cross-reference output	0	00:00:00.00	00:00:00.00
Assembler run totals	294	00:00:02.12	00:00:12.65

The working set limit was 900 pages.
3329 bytes (7 pages) of virtual memory were used to buffer the intermediate code.
There were 10 pages of symbol table space allocated to hold 15 non-local and 1 local symbols.
279 source lines were read in Pass 1, producing 11 object records in Pass 2.
1 page of virtual memory was used to define 1 macro.

! Macro library statistics !

Macro library name	Macros defined
_\$255\$DUA28:[SYSLIB]STARLET.MLB;2	0

0 GETS were required to define 0 macros.

There were no errors, warnings or information messages.

MTHTANH
VAX-11 Macro Run Statistics

6 3
; Floating Point Hyperbolic Tangent rout 16-SEP-1984 01:52:31 VAX/VMS Macro V04-00
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MACRO/ENABLE=SUPPRESSION/DISABLE=(GLOBAL,TRACEBACK)/LIS=LISS:MTHTANH/OBJ=OBJ\$:MTHTANH MSRC\$:MTHJACKET/UPDATE=(ENHS:MTHJACKET)+MSRC\$:

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VAX/VMS V4.0

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