HP-71B and HP-75C Math modules

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This document compares the features of the HP-71B and HP-75C Math modules.

The HP-75C Math pac is a 16 kB ROM module whereas the HP-71B pac is a 32 kB ROM module, from which only 27 kB are actually used.

A quick look at the specifications of both modules shows quite similar features, which may be surprising since the HP-71B code is about 70% bigger.
The goal of the document is to check how close the actual features are.

Both modules provide matrix functions that are derived from the previous series 80 Matrix ROM, so the comparison of these functions will include the series 80 as a reference.

'80' refers here to the whole series 80 machines.

1. Array Input and Output

	71	75	80	comments
MAT A=B	X	X	X	
MAT A(..)=B(..)			X	subarray copy
MAT A=(X)	X	X	X	
MAT A=CON	X	X	X	
MAT A=IDN	X	X	X	
MAT A=ZER	X	X	X	
MAT INPUT A	X	X	X	
MAT READ A		X	X	71: use READ A() or A(,)
MAT DISP [USING] A	X	X	X	
MAT PRINT [USING] A	X	X	X	
REDIM A(..)		X	X	71: use DIM A(..)

Note: The series 80 permits to copy subarrays, such as:
MAT B(3,1:3) = A(1,2:4) or MAT B(3,)=D .
The subarrays can even have zero columns or rows, which can be useful in certain circumstances.
None of the 71 or 75 can do that. Otherwise, no functional differences.

2. Matrix Algebra

	71	75	80	comments
MAT A=-B	X	X	X	
MAT A=B+C	X	X	X	
MAT A=B-C	X	X	X	
MAT A=B*C	X	X	X	matrix multiply
MAT A=B.C			X	element-per-element multiplication
MAT A=B/C			X	element-per-element division
MAT A=(X)*B	X	X	X	multiplication by a scalar
MAT A=(X)+B			X	
MAT A=(X)-B			X	
MAT A=(X)/B			X	
MAT A=(X)*B+(Y)*C			X	
MAT A=CROSS(B,C)		X	X	
MAT A=CSUM(B)		X	X	
MAT A=RSUM(B)		X	X	
MAT A=INV(B)	X	X	X	
MAT A=INV(B)*C			X	
MAT A=TRN(B)	X	X	X	
MAT A=TRN(B)*C	X		X	
MAT A=B*TRN(C)			X	
MAT X=SYS(A,B)	X	X	X	
MAT A=LUFACT(B)		X		

Notes: the series 80 includes the most complete function set, including flexible operations between matrix elements or between matrix and scalar.
It also includes combined operations such MAT A=(X)*B+(Y)*C.
Interesting, the 71 has the MAT A=TRN(B)*C operation as the series 80.
Interesting too, the 75 has an operation to have access to the LU form.
The 71 doesn't have the CROSS, CSUM and RSUM operations.

3. Scalar-Value Matrix Functions

	71	75	80	comments
DET(A)	X	X	X	
DETL	X	X	X	
FNORM(A)	X	X	X	
CNORM(A)	X	X	X	
CNORMCOL			X	
RNORM(A)	X	X	X	
RNORMROW			X	
AMIN(A)		X	X	
AMINCOL			X	
AMINROW			X	
AMAX(A)		X	X	
AMAXCOL			X	
AMAXROW			X	
MINAB(A)		X		
MAXAB(A)		X	X	
MAXABCOL			X	
MAXABROW			X	
SUM(A)		X	X	
ABSUM(A)		X	X	
DOT(X,Y)	X	X	X	
LBND(A,N)	X	X	X	
UBND(A,N)	X	X	X	

Notes: The series 80, again, has the most complete function set, followed by the 75.
The series 80 and the 75 have the AMIN/AMAX/MAXAB/SUM/ABSUM functions.
Interesting, the 75 has a MINAB function that the series 80 doesn't have.
The series 80 has additional functions to identify the row and/or column that correspond to the matrix min/max/norm values.

Matrix functions summary:

Globally, it is clear that the series 80 has the most comprehensive matrix function set.
The 75 shares most of the series 80 features, but lacks several ones.
Finally, the 71 only implements a basic set of most useful matrix operations.

4. Complex Numbers

The implementation of complex numbers is very different on the two machines.
On the 75, complex numbers are managed as 2-element vectors. All operations on complex are using dedicated MAT operations.
On the 71, the operations on complex numbers are using the same functions than on real numbers, the handlers of complex arguments are automatically provided by the Math ROM when present.

Complex creation

	71	75	comments
create cplx	COMPLEX Z	DIM Z(1)	75: assuming OPTION BASE 0
assign parts	Z=(X,Y)	Z(0)=X @ Z(1)=Y	
real part	X=REPT(Z)	X=Z(0)	
imag part	Y=IMPT(Z)	Y=Z(1)	
copy	Z2=Z1	MAT Z2=Z1	
const cplx	(X,Y)		

Mixed operations

	71	75	comments
add a real	Z=Z+X	Z(0)=Z(0)+X	
mult by a real	Z=Z*X	MAT Z=(X)*Z	
real power	Z=Z^X		

Complex Functions and Operations

	71	75	comments
add	Z=Z1+Z2	MAT Z=CADD(Z1,Z2)	
sub	Z=Z1-Z2	MAT Z=CSUB(Z1,Z2)	
minus	Z=-Z1	MAT Z=-Z1	
mult	Z=Z1*Z2	MAT Z=CMULT(Z1,Z2)	
div	Z=Z1/Z2	MAT Z=CDIV(Z1/Z2)	
power	Z=Z1^Z2	MAT Z=CPOWER(Z1,Z2)	
inverse	Z=1/Z1	MAT Z=CRECP(Z1)	
log	Z=LOG(Z1)	MAT Z=CLOG(Z1)	
exp	Z=EXP(Z1)	MAT Z=CEXP(Z1)	
rect-pol	A=POLAR(Z)	MAT A=CRTOP(Z)	
pol-rect	Z=RECT(A)	MAT Z=CPTOR(A)	
sqrt	Z=SQR(Z1)	MAT Z=CSQR(Z1)	
sign	Z=SGN(Z1)		
abs	X=ABS(Z)		
arg	X=ARG(Z)		
conj	Z=CONJ(Z1)	MAT Z=CONJ(Z1)	
proj	Z=PROJ(Z1)		
sin	Z=SIN(Z1)	MAT Z=CSIN(Z1)	
cos	Z=COS(Z1)	MAT Z=CCOS(Z1)	
tan	Z=TAN(Z1)	MAT Z=CTAN(Z1)	
asin		MAT Z=CASIN(Z1)	
acos		MAT Z=CACOS(Z1)	
atan		MAT Z=CATN(Z1)	
sinh	Z=SINH(Z1)	MAT Z=CSINH(Z1)	
cosh	Z=COSH(Z1)	MAT Z=CCOSH(Z1)	
tanh	Z=TANH(Z1)	MAT Z=CTANH(Z1)	
asinh		MAT Z=CASINH(Z1)	
acosh		MAT Z=CACOSH(Z1)	
atanh		MAT Z=CATANH(Z1)	
tests	Z1=Z2,Z1#Z2		

The 71 can easily manages equations combining several operations whereas the 75 must manage them by individual operations, e.g. :
71:
```
Z=Z1*Z2/Z3+Z4
```
75:
```
MAT Z=CMULT(Z1,Z2)
MAT Z=CDIV(Z,Z3)
MAT Z=CADD(Z,Z4)
```
Otherwise, both machines have a good function set.

The 75 is missing the SGN, ABS and ARG operations and an easy way to compare complex numbers.
The 71 is, surprising, missing the inverse trigonometric and hyperbolic functions.

5. Complex Matrix

Complex matrices on the 75 use the same mechanism: complex numbers are stored in two elements of a real matrix. A complex matrix NxP is stored in NxPx2 elements.

Complex Matrix Creation

	71	75	comments
Create cplx vect	COMPLEX Z(n)	DIM/REDIM Z(n,2)	
Create cplx mat	COMPLEX Z(n,p)	DIM/REDIM Z(n,p*2)	

Notes:
The exact n and p values are depending on the OPTION BASE.
On the 75, n and p must be constant values, or REDIM must be used

Complex Matrix Operations

	71	75	comments
det		MAT Z=CDET(A)	missing on the 71
idn	MAT A=IDN	MAT A=CIDN	
zer	MAT A=ZER	MAT A=ZER	
inv	MAT A=INV(B)	MAT A=CINV(B)	
mult	MAT A=B*C	MAT A=CMMULT(B,C)	
sys	MAT Z=SYS(A,B)	MAT Z=CSYS(A,B)	
complex trans	MAT A=TRN(B)	MAT A=CTRN(B)	

The 71 accepts complex vectors or matrices in all matrix operations, except DET. The 75 is using dedicated operations for only a subset of the matrix operations.

The 71 and 75 functions are similar for the subset that the 75 is supporting. However, the manipulation of complex arrays is much easier on the 71.

6. Base Conversion

	71	75	Comments
BVAL(X$,N)	X	X	
BSTR$(X,N)	X	X	

The 71 and 75 have equivalent functions.

7. Real Scalar Functions

	71	75	Comments
SINH(X)	X	X	
COSH(X)	X	X	
TANH(X)	X	X	
ASINH(X)	X	X	
ACOSH(X)	X	X	
ATANH(X)	X	X	
GAMMA(X)	X		
FACT(X)		X	FACT on the 75 combines fact and gamma
LOG2(X)	X	X	
LOGA(X,B)		X	log in base B
IROUND(X)	X		round to integer
ROUND(X,N)		X	round to N decimal places (to integer if N=0)
TRUNCATE(X,N)		X	truncate to N decimal places (to integer if N=0)
SCALE10(X,N)	X		
NAN$	X		
NEIGHBOR(X)	X		
TYPE(X)	X		

Note: the 71 and 75 have equivalent hyperbolic, gamma and log2 functions. Each machines adds a few specific functions, we may say the 75's LOGA, ROUND and TRUNCATE functions have more general use than the 71's SCALE10, NAN$, NEIGHBOR and TYPE functions.

8. FNROOT and INTEGRAL

	71	75	Comments
FNROOT(A,B,F)	X	X	
FVAR	X		
FVALUE	X		
FGUESS	X	X	(75: FNGUESS)
INTEGRAL(A,B,E,F)	X	X	
IVAR	X		
IVALUE	X	X	
IBOUND	X	X	

Notes:

The 75 doesn't have the FVAR/IVAR keywords and has to use a User Defined Function (UDF) to define the function in FNROOT and INTEGRAL, using the following syntax:

```
 FNROOT(A,B,FNF(X))
 INTEGRAL(A,B,E,FNF(X))
```

As it is not possible to call a UDF from the keyboard, FNROOT and INTEGRAL are only usable in a program.

The 71 doesn't have these limitations, it accepts a UDF or an explicit function using the reserved FVAR/IVAR keywords to define the variable to be solved, or the integration variable.

Furthermore, it is possible to have nested FNROOT or INTEGRAL on the 71, up to 5 levels, allowing to solve non-linear systems of equations and calculate multiple integrals. This is not possible on the 75.
However, it is possible to have FNROOT calling INTEGRAL (or the other way) on both machines.

The two machines have similar functions but the 71 versions have a better implementation and are more powerful especially due to the possibility to have nested FNROOT/INTEGRAL.

9. PROOT, FOUR and CROOT

	71	75	Comments
MAT R=PROOT(P)	X	X	Roots of Polynomials
MAT W=FOUR(Z)	X	X	Finite Fourier Transform
MAT R=CROOT(Z,N)		X	Roots of a Complex Number

Notes:
The PROOT and FOUR operations are similar on the two machines but the structure of the input/output arrays is different due to the way the 71 and 75 are managing complex numbers.
The CROOT operation only exists in the 75 Math ROM, it finds all the Nth roots of a complex number.