Author(s) : K.S. Kölbig **Library:** MATHLIB
Submitter : **Submitted:** 15.11.1995
Language : Fortran **Revised:**

Psi (Digamma) and Polygamma Functions for Complex Argument

Function subprograms `CPSIPG` and `WPSIPG` calculate either the logarithmic derivative of the gamma function (the psi, or digamma, function)

$$\psi(z) \;\equiv\; \psi^{(0)}(z) \;=\; \frac{d\ln\Gamma(z)}{dx}$$

or one of the other polygamma functions

$$\psi^{(k)}(z) \;=\; \frac{d^k}{dz^k}\,\psi(z) \;=\; \frac{d^{k+1}}{dz^{k+1}}\,\ln\Gamma(z)$$

for complex arguments $z \neq -n$, $(n = 0, 1, 2, \dots)$ and $k = 0, 1, 2, 3, 4$.
The double-precision version `WPSIPG` is available only on computers which support a `COMPLEX*16` Fortran data type.

Structure:

`FUNCTION` subprograms
User Entry Names: `CPSIPG`, `WPSIPG`
Files Referenced: `Unit 6`
External References: `MTLMTR` (N002), `ABEND` (Z035)

Usage:

In any arithmetic expression,

`CPSIPG(Z,K)` or `WPSIPG(Z,K)` has the value $\psi^{(\mathtt{K})}(\mathtt{Z})$,

where `CPSIPG` is of type `COMPLEX`, `WPSIPG` is of type `COMPLEX*16`, and where `Z` has the same type as the function name. `K` is of type `INTEGER`.

Method:

The method for $\psi(z)$ described in Ref. 1 is adapted accordingly.

Accuracy:

`CPSIPG` (except on CDC and Cray computers) has full single-precision accuracy. For most values of the argument `Z`, `WPSIPG` (and `CPSIPG` on CDC and Cray computers) has an accuracy of approximately two significant digit less than the machine precision.

Error handling:

Error `C317.1`: $\mathtt{K} < 0$ or $\mathtt{K} > 4$.
Error `C317.2`: $\mathtt{X} = -n$, $(n = 0, 1, 2, \dots)$.
In both cases, the function value is set to zero, and a message is written on `Unit 6`, unless subroutine `MTLSET` (N002) has been called.

References:

1. K.S. Kölbig, Programs for computing the logarithm of the gamma function, and the digamma function, for complex arguments, Computer Phys. Comm. **4** (1972) 221-226.

•