Special Functions for Trigonometric, Inverse Trigonometric and Angle Units Conversions

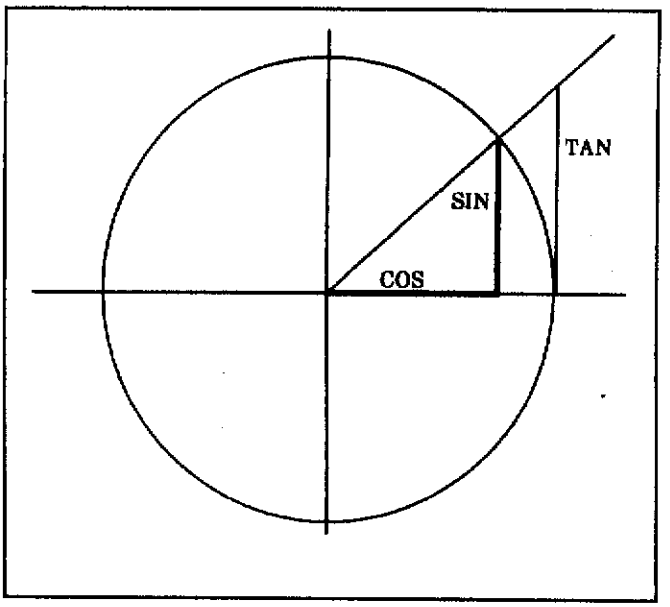
SIN S70
COS S71
TAN S72
DEGRAD S75
ASIN S80
ACOS S81
ATAN S82
RADDEG S85
PI S77

DESCRIPTION

The Special Functions described in this data sheet provide trigonometric, inverse trigonometric and angle units conversions. They are single-branch input functions, with no VALUE table. They simply provide a rung output that is the specified function of the rung input.

The trigonometric functions operate with angles in radians only. If you need to convert angles to or from degrees, then you should use the conversion Special Functions S75 DEGRAD (degrees to radians) and S85 RADDEG (radians to degrees). In addition, there is the function S77 PI that gives you the value of pi as a floating point number.

All these trigonometric and conversion functions are available only on GEM 80 Controllers with floating point mathematics facilities. Their rung outputs are always floating point numbers, but their inputs may be either floating point or integer.



SPECIFICATIONS

SIN (S70)

Control language:

```
                SIN
X---------------SPEC.---------------Q
                S70
```

Equation:

Q = sin X

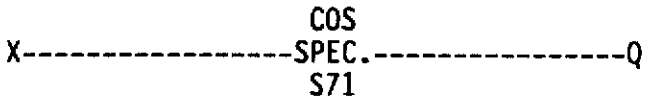
where:

X = rung input in radians (either integer or floating point)

Q = rung output (floating point, in the range –1 to +1)

COS (S71)

Control language:



Equation:

$Q = \cos X$

where:

X = rung input in radians (either integer or floating point)

Q = rung output (floating point, in the range –1 to +1)

TAN (S72)

Control language:

Equation:

$Q = \tan X$

where:

X = rung input in radians (either integer or floating point)

Q = rung output (floating point, up to the maximum representable floating point number)

ASIN (S80)

Control language:

Equation:

$Q = \arcsin X = \sin^{-1} X$

where:

X = rung input (either integer or floating point, and must be in the range –1 to +1)

Q = rung output in radians (floating point, in the range $-\Pi/2$ (when X = –1) to $+\Pi/2$ (when X = +1))

If X lies outside the legal range of +1, then the output Q will be of a form that does not represent a valid number, and will not be usable in any subsequent calculations. You can detect this error using the S78 Special Function FPFLAGS; refer to the Software Date Sheet for this function for details.

ACOS (S81)

Control language:

Equation:

$Q = \arccos X = \cos^{-1} X$

where:

X = rung input (either integer or floating point, and must be in the range –1 to +1)

Q = rung output in radians (floating point, in the range pi (when X = –1) to 0 (when X = +1))

If X lies outside the legal range of +1, then the output Q will be of a form that does not represent a valid number, and will not be usable in any subsequent calculations. You can detect this error using the S78 Special Function FPFLAGS; refer to the Software Date Sheet for this function for details.

ATAN (S82)

Control language:

Equation:

$$Q = \arctan X = \tan^{-1} X$$

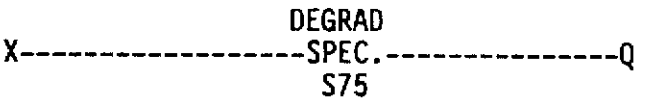
where:

X = rung input (either integer or floating point, of any size within the available number range)

Q = rung output in radians (floating point, in the range $-\Pi/2$ (when X = maximum negative number) to $+\Pi/2$ (when X = maximum positive number))

DEGRAD (S75)

Control language:



Equation:

$$Q = \frac{\Pi}{180} X$$

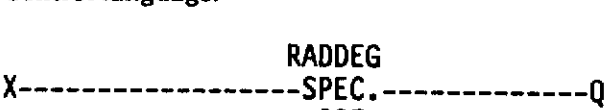
where:

X = rung input in degrees (either integer or floating point, of any size within the available number range)

Q = rung output in radians (floating point)

RADDEG (S85)

Control language:



Equation:

$$Q = \frac{180}{\Pi} X$$

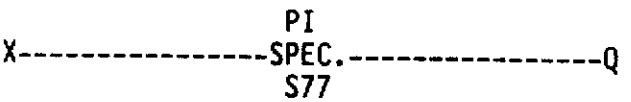
where:

X = rung input in radians (either integer or floating point, of any size within the available number range)

Q = rung output in degrees (floating point)

PI (S77)

Control language:



Equation:

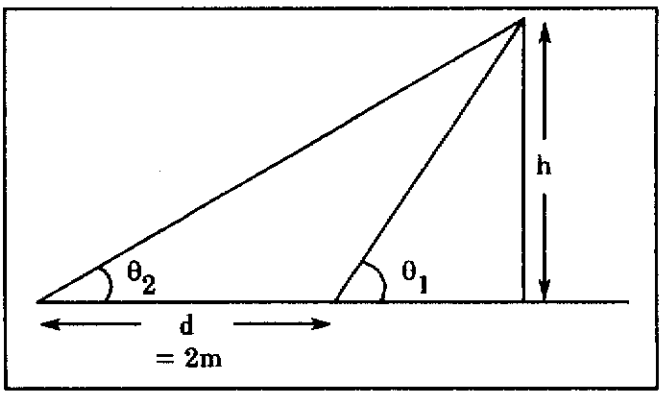
Q = Π

where:

X, which must not be floating point, is ignored. If you try to use a floating point number for the input, you will get a compilation error, and your program won't run.

EXAMPLES OF USE

1. Two photoscanners spaced 2 metres apart continuously monitor the angle of elevation at which a thin rod is passing. The problem is to calculate the height of the rod above the scanners.



If the angles of elevation at which the rod is detected by the two scanners are θ_1 and θ_2, then it can be shown that the height of the rod is given by the formula:

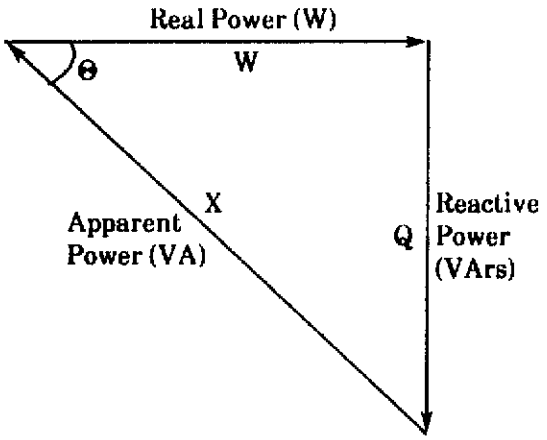
$$h = \frac{d}{\frac{1}{\tan\theta_2} \quad \frac{1}{\tan\theta_1}}$$

This can be directly represented in ladder diagram form as follows:

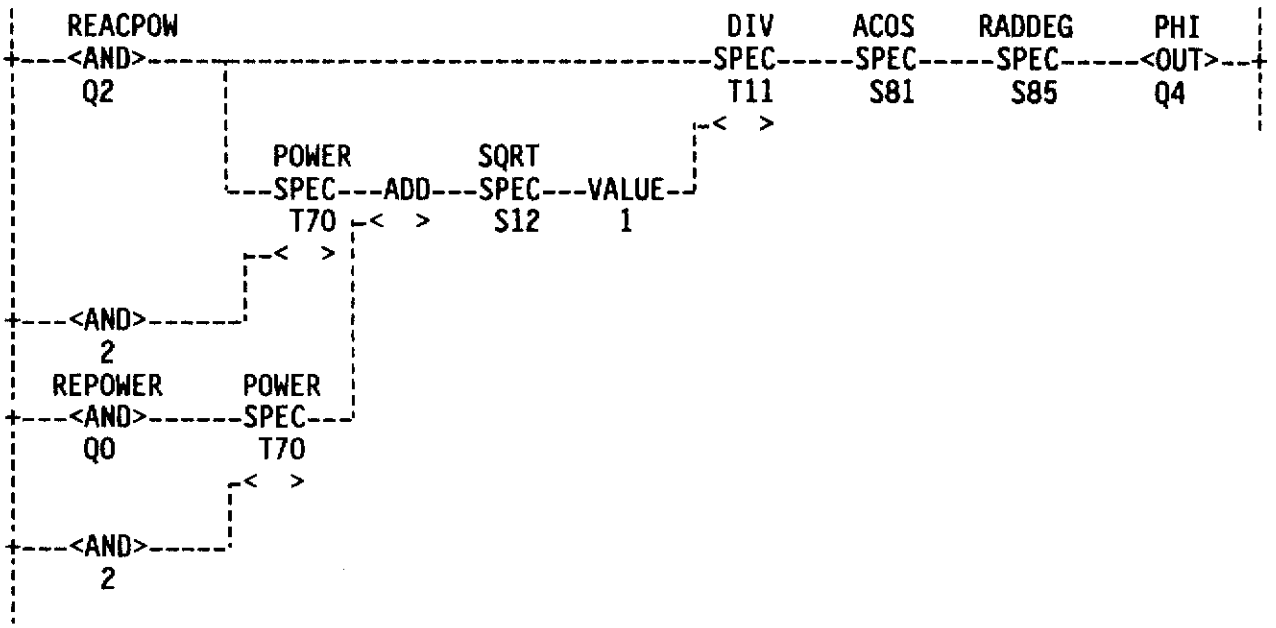
```
|  D                              DIV      H  |
+<AND>-----------------------SPEC--<OUT>+
| Q10                           T11     Q20  |
|                              +<   >        |
|              DIV             |              |
+<AND>---------SPEC--<SUB>-+                 |
|  1           T11    <   >                  |
|            +<    > +<    >                 |
|THETA2 TAN |         |                       |
+<AND>-SPEC-+         |                       |
| Q14  S72           |                       |
|                    |                       |
|              DIV   |                       |
+<AND>---------SPEC-+                        |
|  1           T11                           |
|            +<    >                         |
|THETA1 TAN |                                  |
+<AND>-SPEC-+                                 |
| Q12  S72                                    |
```

This diagram assumes that the angle values are already in radians. Otherwise, you would have to use the DEGRAD conversion function (S75) in the third and fifth branches after bringing in the angles THETA1 and THETA2 and before taking their tangents.

2. Power Factor Calculation

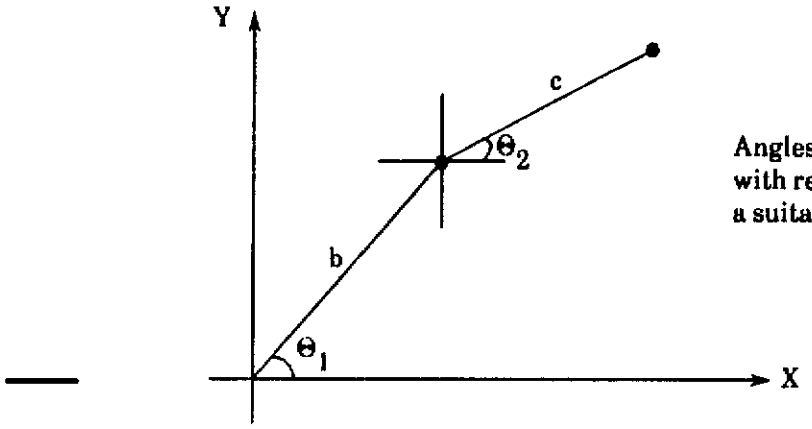


$$\Theta = \cos^{-1}\left[\frac{Q}{\sqrt{W^2 + Q^2}}\right]$$

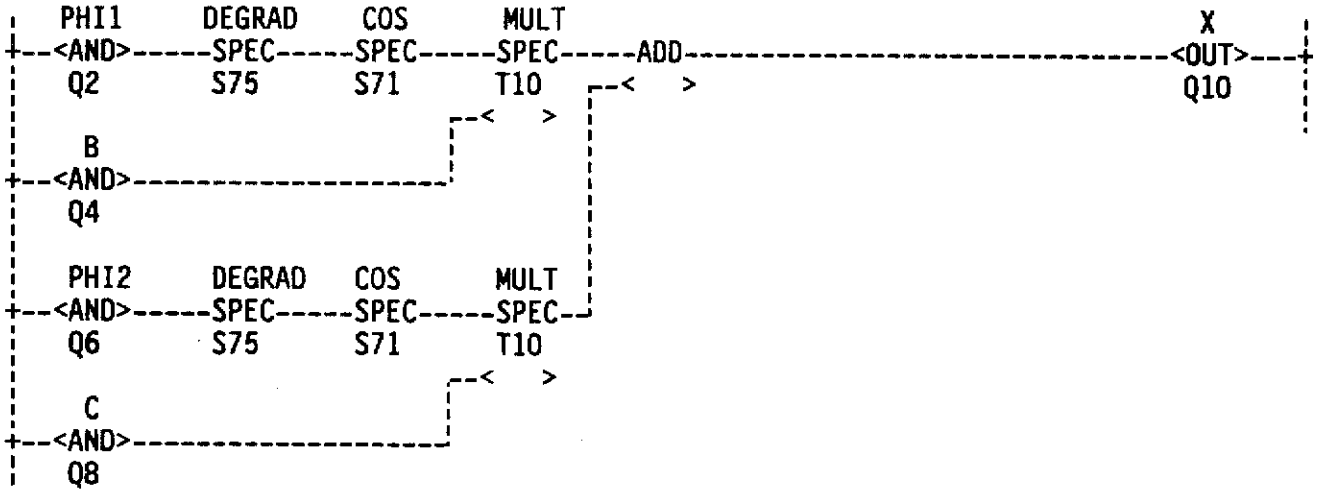


The program calculates the phase angle between the current and voltage as supplied to a reactive load. The calculation is performed assuming that the real and reactive power values are known.

3. Robot Arm Moving in two Axes



$$X = b\cos\Theta_1 + c\cos\Theta_2$$



The program calculates the X co-ordinate of a robot arm moving in two axes via angles being measured with respect to a suitable datum.

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