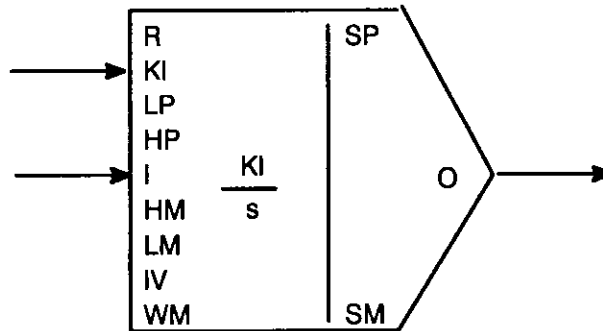


42.0 INTEGRATE

This function can be used in AutoMax Control Block tasks and UDC Control Block tasks.



Function

$$\text{LAPLACE TRANSFER FUNCTION} = \frac{\text{KI}}{s}$$

Program Statement

```
CALL INTEGRATE(INPUT = input%,           &
  KI = ki,                                 &
  WM = nnn.n,                              &
  INITIAL_VALUE = initial_value%,         &
  LIMIT_PLUS = limit_plus%,              &
  LIMIT_MINUS = limit_minus%,            &
  RESET = reset@,                         &
  HOLD_PLUS = hold_plus@,                 &
  HOLD_MINUS = hold_minus@,               &
  SATURATED_PLUS = saturated_plus@,      &
  SATURATED_MINUS = saturated_minus@,    &
  OUTPUT = output%)
```

Inputs

R (RESET) =

BOOLEAN integrator reset. The default for this parameter is FALSE. When this parameter is TRUE, OUTPUT will be held at INITIAL_VALUE.

KI (KI) =

REAL integrator gain. This parameter must be specified. You must include a decimal point in the actual value.

LP (LIMIT_PLUS) =

INTEGER integrator upper limit. The default for this parameter is 32767. This parameter will limit OUTPUT from becoming more positive. It will not prevent the output value from becoming more negative.

HP (HOLD_PLUS) =

BOOLEAN integrator hold plus. The default for this parameter is FALSE. When this parameter is TRUE, OUTPUT will be prevented from becoming more positive. It will be permitted to go more negative.

I (INPUT) =

INTEGER signal input. This parameter must be specified.

HM (HOLD_MINUS) =

BOOLEAN integrator hold minus. The default for this parameter is FALSE. When this parameter is TRUE, OUTPUT will be prevented from becoming more negative. It will be permitted to go more positive.

LM (LIMIT_MINUS) =

INTEGER integrator lower limit. The default for this parameter is -32767. This parameter will limit OUTPUT from becoming more negative. It will not prevent the output value from becoming more positive.

IV (INITIAL_VALUE) =

INTEGER initial value of integrator. The default for this parameter is zero.

WM (ω_m) =

Mapping frequency in radians/second. If specified, this parameter must be entered explicitly as a REAL literal. The default value for this parameter is ω_s divided by 20 where ω_s is the frequency in rad/sec. You must include a decimal point in the actual value.

Outputs

SP (SATURATED_PLUS) =

BOOLEAN SATURATED plus output. This parameter is optional. TRUE if OUTPUT% reaches LIMIT(+).

O (OUTPUT) =

INTEGER signal output. This parameter must be specified.

SM (SATURATED_MINUS) =

BOOLEAN saturated minus output. This parameter is optional. TRUE if OUTPUT% reaches LIMIT(-).

42.1 INTEGRATE ω_m Limitations

ω_m is equal to or greater than 0.01. ω_m is equal to or less than 0.9π divided by T.

Low Limit = .01

High Limit = $\frac{0.9\pi}{T}$

where:

T = scan period in seconds

C = number of CPU clock ticks times tick rate

42.2 INTEGRATE K1 Limitations

K1 is equal to or greater than the value 0.00137573 divided by TICKS. K1 is equal to or less than 0.9π divided by T.

Low Limit = $C(2^{-18})$

$$= \frac{\omega m(2^{-18})}{\text{TAN}\left(\frac{\omega m * T}{2}\right)}$$

High Limit = $\frac{0.9\pi}{T}$

If ωm is defaulted ($\omega m = \omega s \div 20$):

Low Limit = $(2^{-18}) \frac{1.9835}{T}$

where:

T = scan period in seconds

C = number of CPU clock ticks times tick rate

ωs = scan frequency in radians/second

$$= \frac{2\pi}{T}$$

C = bilinear mapping constant

$$= \frac{\omega m}{\text{TAN}\left(\frac{\omega m * T}{2}\right)}$$

$2^{-18} = 3.814697266E-06$

Refer to section 51.0, Special Coefficient Restrictions, for further restrictions. █

42.3 Calculating K1 for INTEGRATE Time Domain Applications

The following describes calculating K1 when the INTEGRATE block is used for its time domain characteristics. When used in this manner, the frequency characteristics of the block are of no concern. Therefore, the ωm specification will always be defaulted (not specified).

Calculate K1 such that OUTPUT will accumulate (change) by "y" counts/second with a constant "x" INPUT value and a scan period of "t" TICKS. The equation executed by the INTEGRATE block is as follows:

$$\text{OUTPUT} = Kx[\text{INPUT} + \text{INPUT}(n-1)] + \text{OUTPUT}(n-1)$$

where:

$$Kx = \frac{K1}{C}$$

$$c = \frac{\omega m}{\text{TAN} \left(\frac{\omega m * T}{2} \right)}$$

Since ωm is defaulted ($\omega m = \omega s \div 20$ where $\omega s = 2\pi \div T$):

$$\omega m = \frac{2\pi}{20T} = \frac{\pi}{10T}$$

Therefore,

$$\begin{aligned} C &= \frac{\left(\frac{\pi}{10T} \right)}{\left(\frac{\pi}{10T} \right) \left(\frac{T}{2} \right)} \\ &= \frac{\frac{\pi}{10T}}{0.15838} \\ &= \frac{1.9835}{T} \end{aligned}$$

Determine the Counts/Scan as follows:

$$\text{Counts/Scan} = \frac{y \text{ Counts/Second}}{\text{Scan/Second}}$$

$$\begin{aligned} &= \left(\frac{\frac{y}{1}}{T} \right) \\ &= y * T \end{aligned}$$

Because OUTPUT = Counts/Scan = $Kx(2x)$, solve for Kx :

$$\begin{aligned} Kx &= \left(\frac{\text{Counts/Scan}}{2x} \right) \\ &= \frac{y * T}{2x} \end{aligned}$$

To solve $K1$ in the formula $Kx = \frac{K1}{C}$:

$$\begin{aligned} K1 &= Kx * C \\ &= \left(\frac{y * T}{2x} \right) \left(\frac{1.9835}{T} \right) \\ &= \left(\frac{y * 1.9835}{2x} \right) \\ &= 0.99179 \left(\frac{y}{x} \right) \end{aligned}$$

For example, if an application required that the output integrate 1200 counts/second with a constant input value of 2000, we calculate for K1 as follows:

$$\begin{aligned} K1 &= 0.99179 \left(\frac{y}{x} \right) \\ &= 0.99179 \left(\frac{1200}{2000} \right) \\ &= .59507 \end{aligned}$$