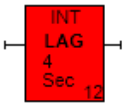
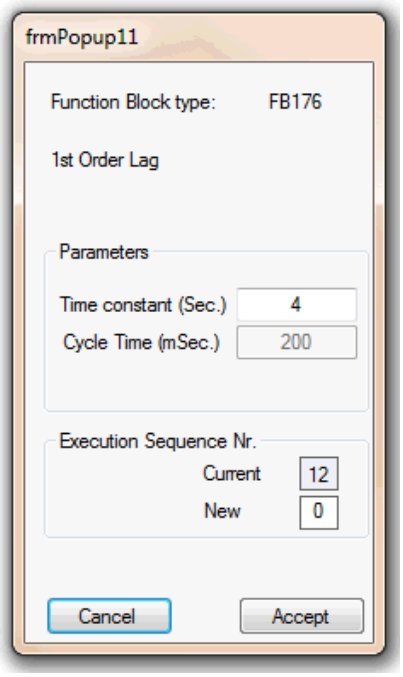
# Function Block 176 1st Order Lag

---

**Function Description**
The output of this function will reach 63.2 percent of its input value after $T_1$ time, and, for all practical purpose, 100 percent after 5 times $T_1$.

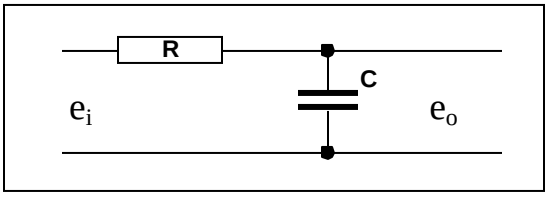



**Popup Parameters**

- User must enter a value for $T_1$, the Time constant. Note that values of less than 10*Ts (the Cycle Time) will not give practical results and should be avoided.
- Execution Sequence Nr.

**Algorithm Description**
The algorithm for this function is derived from the basic circuit for a first order lag.




For the above circuit the following applies:

$$RC\frac{de_o}{dt} + e_o = e_i \qquad \text{----------(1)}$$

Make the following replacements in (1):

| | | |
|---|---|---|
| RC | = $T_1$ | .....Time Constant |
| $de_o$ | = $D_n - D_{n-1}$ | .....Amount that $e_o$ changed in time dt |
| $e_o$ | = $D_n$ | .....Where $D_n$ is the value of the output at sample n, and $D_{n-1}$ is the value of the output at the previous sample. |
| dt | = $T_S$ | .....Sample time, the time duration between measurements $D_n$ and $D_{n-1}$ (i.e. the Time task cycle time). |
| $e_i$ | = $X_n$ | .....Where $x_n$ is the value at the input at sample n. |

and you obtain the following:

$$T_1\frac{(D_n - D_{n-1})}{T_S} + D_n = X_n \qquad \text{----------(2)}$$

With a little manipulation you can rearrange the expression in (2) to the following:

$$D_n = D_{n-1} + \frac{T_S}{T_1 + T_S}(X_n - D_{n-1}) \qquad \text{----------(3)}$$

This gives us the value of the current output in terms of the previous output and the current input value, and is implemented in this function block.

**Inputs and Output**

| Type | Description | Data Type | Range |
|---|---|---|---|
| Input | Input signal | INT | -32768……+32767 |
| Output | Output signal | INT | -32768……+32767 |

**Application**

As Function Block 176 must be executed at the sample time $T_S$ it can only be used in Time Tasks.

Function Block 176 can also be used as a low-pass filter, where the 3 dB point is at a frequency given by:

$$F_{3dB} = \frac{1}{2\pi T_1}$$

The function block is also very handy for simulating simple processes together with the Dead-time function block.

---