Chapter 25

LOADS

Edition 2

Overview

This chapter describes the LOADS class of Function Blocks which provide models of commonly encountered controller loads. They may be used to simulate plant operation without the use of physical, hardware I/O. They may be used as a debugging tools. For example a PID_Load can be connected to a PID Function Block to simulate a complete control loop. The user program interaction with the PID Function Block can be tested without connecting to the physical plant, furnace etc.

PID_LOAD FUNCTION BLOCK

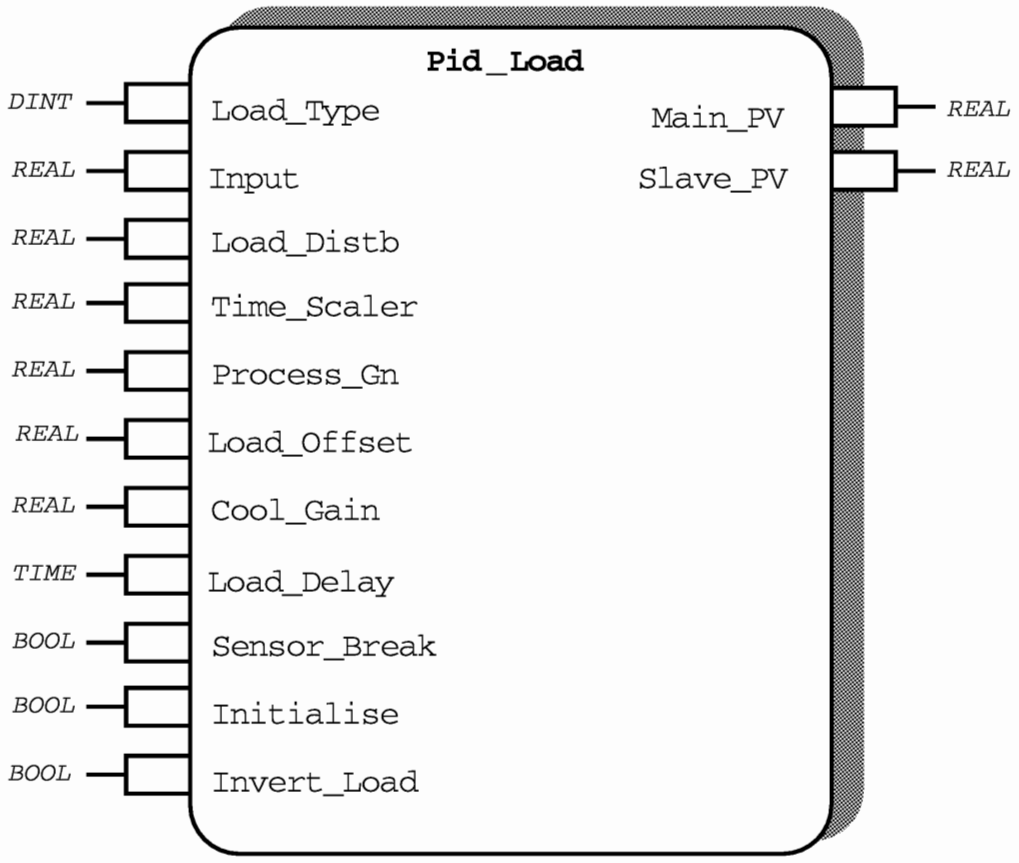

Figure 25-1 PID_Load Function Block

Functional Description

The PID_Load function block simulates the behaviour of three types of temperature controlled loads for use in closed loop control simulation tests. It is made up of a series of cascaded lags, with definable time scaler, gain and disturbance load. The function block can be configured to simulate a furnace, an extruder barrel zone, or a furnace with dead time.

Configuring Pid_Load for Control Loop Simulation

When employing Pid_Load in a PC3000 simulation, it is usual to build a model in which the function block is being controlled in closed loop by either the PID or PID_Auto function blocks. An example of the soft wiring for controlling Pid_Load by the PID function block is shown below.

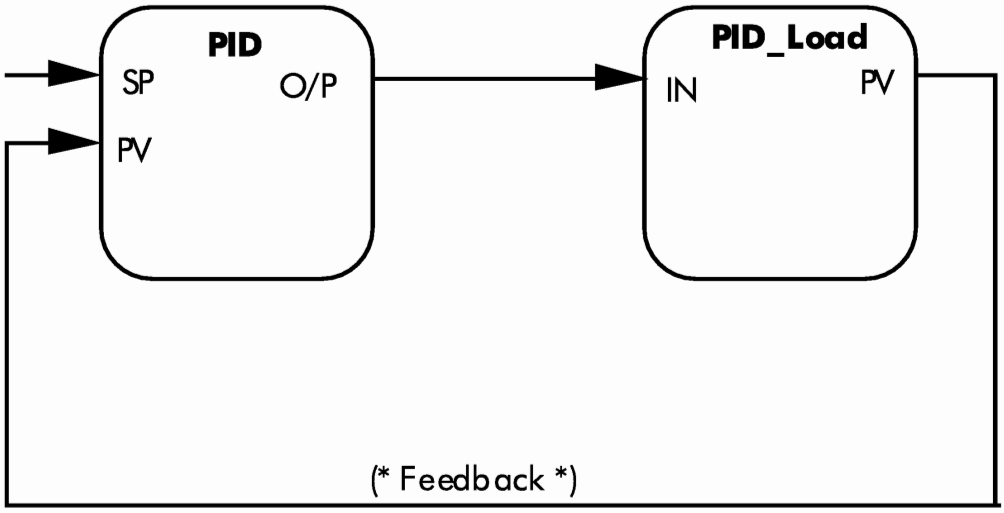

Figure 25-2 Soft Wiring of Pid_Load and PID.

To operate the function block in the configuration shown above, it is necessary to properly tune the PID controller to give a stable response. This can be carried out using the Autotuner, after having configured the load to approximate the system it is simulating. Examples of typical PID values are given in the table below for Load_Type's 1,2 and 3, including the load parameter values for which the PID tuning will produce a stable response.

Function Block Attributes

Type: .....fO 10

Class:.....LOADS

Default Task: .....Task_2

Short List: .....Load_Type, Main_PV, Slave_PV, Input

Memory Requirements: .....1802 Bytes

Execution Time: 14.0mSecs

Parameter	Load Type		
	1	2	3
Load_Distb	0	0	0
Time_Scaler	1	1	1
Process_Gn	2	2	2
Load_Offset	0	0	0
Cool_Gain	1	1	1
Load_Delay	0	0	20s
Prop_Band	5%	12%	30%
Integral	24s	72s	75s
Derivative	4s	12s	12s_500ms

Table 25-1 Typical load configuration and PID values for tuned load simulation.

Parameter Descriptions

Load_Type (LT)

Load_Type allows selection of the type of load which is being simulated by the function block. It can be set to one of three types:

1: Furnace

2: Extruder barrel zone

3: Furnace with dead-time.

Input (IN)

Input is the input to the function block.

Load_Distb (LD)

Load_Distb can be used to simulate a disturbance load, such as a heat loss, which is added directly to the Input to the function block.

Time_Scaler (TS)

Time_Scaler acts as a scaler on the first order lags of the function block. Setting Time_Scaler to 1 enables the simulation models to provide a real time representation of actual systems. Values less than 1 signify faster than real time and values greater than 1 represent systems slower than real time.

Process_Gn (PG)

Process_Gn is the steady state gain of the simulated process. The steady state values of Main_PV and Slave_PV will be equal to Input Process_Gn, so it is important that the value of Process_Gn is selected to take account of both the span of the simulated control application and the gain of the process.

Load_Offset (LO)

Load_Offset has no function in the PID_Load function block. It has been included for future enhancement.

Cool_Gain (CG)

Cool_Gain provides the ability to introduce non-linear heating and cooling into the load simulation. Setting Cool_Gain to a value less than 1 reduces the time constant of the load when its Input is less than 0, thus simulating a fast cool response. Setting Cool_Gain to a value greater than 1 simulates a slow cool response by increasing the time constant of the load for Inputs of less than 1. Setting Cool_Gain to 1 simulates a linear heat - cool response, with a constant load time constant for all Input values.

Load_Delay (DEL)

Load_Delay is only used when Load_Type is set to 3. It defines the length of the time delay which is included in the simulation model.

Sensor_Break (SBR)

When Sensor_Break is set to BREAK (1), the function block simulates a sensor break condition. In this state Main_PV ramps to 200 % and Slave_PV ramps to Input Process_Gn. When Sensor_Break is reset to NO_BRK (0), normal load simulation will resume.

Initialise (INI)

Setting Initialise to Init (1) freezes the operation of the function block, with Main_PV and Slave_PV being held at constant values. On the leading edge of resetting Initialise from Init (1) to Run (0), Main_PV and Slave_PV be reset to zero and the simulation will resume.

Invert_Load (IL)

Invert_Load has no function in the PID_Load function block. It has been included for future enhancement.

Main_PV (PV)

Main_PV is the main simulated process value (i.e. simulated temperature) output of the function block.

Slave_PV (SPV)

Slave_PV is an intermediate process value, which is taken from the output of an intermediate lag in the simulation model. It is intended for use in master / slave cascaded control loop simulations.

Parameter Attributes

Name	Type	Cold Start	Read Access	Write Access	Type Specific Information	
Load_Type	**DINT**	1	Oper	Oper	High Limit Low Limit	3 1
Input	**REAL**	0	Oper	Oper	High Limit Low Limit	1000 -1000
Load_Distb	**REAL**	0	Oper	Oper	High Limit Low Limit	10 0
Time_Scaler	**REAL**	1	Oper	Oper	High Limit Low Limit	30 0.3
Process_Gn	**REAL**	1	Oper	Oper	High Limit Low Limit	100 0.1
Load_Offset	**REAL**	0	Oper	Oper	High Limit Low Limit	100 -100
Cool_Gain	**REAL**	1	Oper	Oper	High Limit Low Limit	10 0.1
Load_Delay	**TIME**	0	Oper	Oper	High Limit Low Limit	25s 0
Sensor_Break	**BOOL**	NO_BRK (0)	Oper	Oper	Senses	NO_BREAK (0) BREAK (1)
Initialise	**BOOL**	Run (0)	Config	Config	Senses	Run (0) Init (1)
Invert_Load	**BOOL**	No (0)	Config	Config	Senses	No (0) Yes (1)
Main_PV	**REAL**	0	Oper		High Limit Low Limit	1000 -1000
Slave_PV	**REAL**	0	Oper		High Limit Low Limit	1000 -1000

Table 25-2 PID_Load Parameter Attributes

VP_LOAD FUNCTION BLOCK

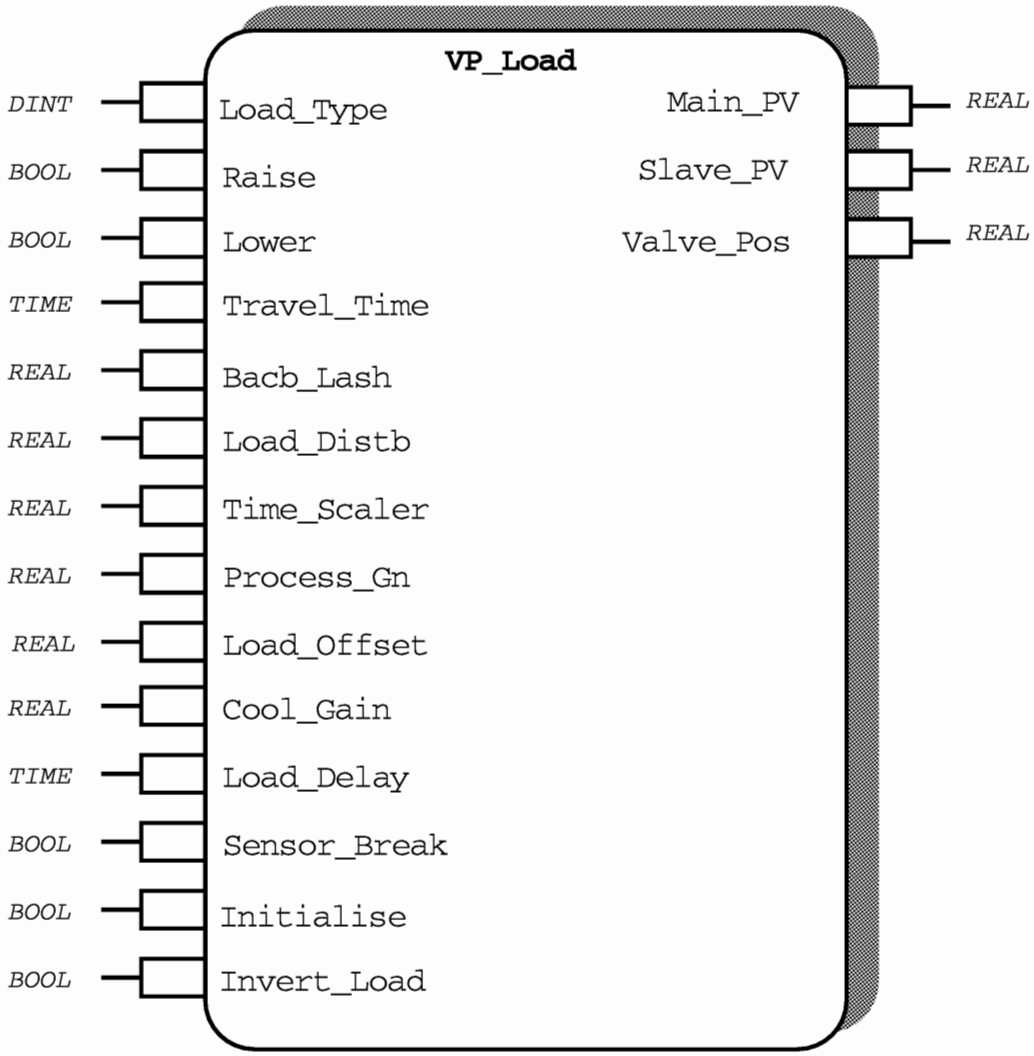

Figure 25-3 VP_Load Function Block

Functional Description

The VP_Load function block simulates the behaviour of three types of temperature controlled, valve positioner driven loads for use in closed loop control simulation tests. It is made up of a series of cascaded lags, with definable time scaler, gain and disturbance load. The function block can be configured to simulate a furnace, an extruder barrel zone, or a furnace with dead time.

Configuring VP_Load for Control Loop Simulation

When employing VP_Load in a PC3000 simulation, it is usual to build a model in which the function block is being controlled in closed loop by either the VP or VP_Auto function blocks. An example of the soft wiring for controlling VP_Load by the VP function block is shown below.

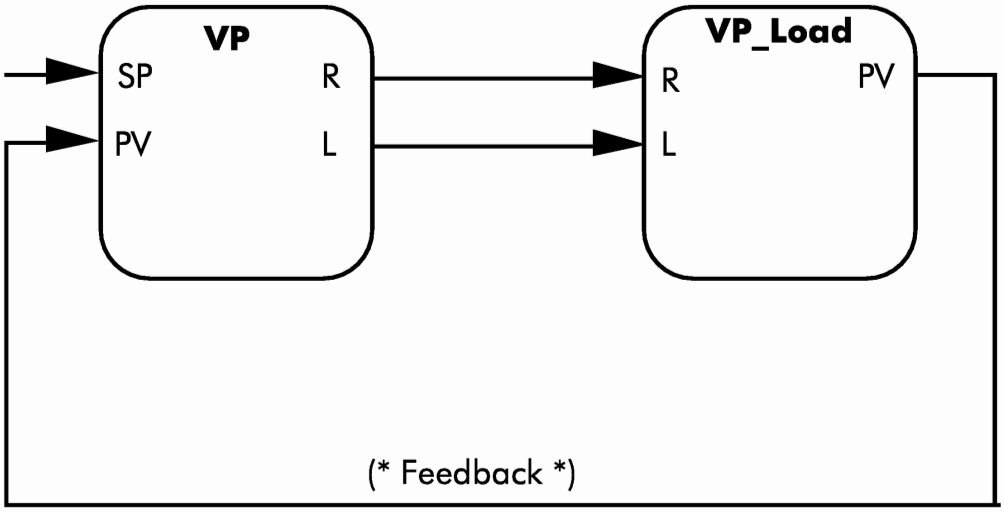

Figure 25-4 Soft Wiring of VP_Load and VP.

To operate the function block in the configuration shown above, it is necessary to properly tune the PID controller to give a stable response. This can be carried out using the Autotuner, after having configured the load to approximate the system it is simulating. Examples of typical PID values are given in the table below for VP Load_Type's 1,2 and 3, including the load parameter values for which the PID tuning will produce a stable response.

Function Block Attributes

Type: fO2O

Class:.....LOADS

Default Task: .....Task_2

Short List: .....Raise, Lower, Main_PV, Valve_Pos

Memory Requirements: .....1836 Bytes

Execution Time: .....14,300 µ Secs

Parameter	Load Type		
	1	2	3
Travel_Time	10s	10s	10s
Back_Lash	1.0%	1.0%	1.0%
Load_Distb	0	0	0
Time_Scaler	1	1	1
Process_Gn	2	2	2
Load_Offset	0	0	0
Cool_Gain	1	1	1
Load_Delay	0	0	20s
Prop_Band	10%	17.5%	70%
Integral	42s	1m_30s	1m_30s
Derivative	7s	15s	0

Table 25-3 VP_Load Parameter Types

Parameter Descriptions

Load_Type (LT)

Load_Type allows selection of the type of valve positioner driven load which is being simulated by the function block. It can be set to one of three types:

1: Furnace

2: Extruder barrel zone

3: Furnace with dead-time.

Raise (R)

Raise is the input to the function block which causes the simulated valve to raise.

Lower (L)

Lower is the input to the function block which causes the simulated valve to lower.

Travel_Time (TT)

Travel_Time defines the amount of time it takes the simulated valve to move between the fully closed and fully open positions.

Back_Lash (BL)

Back_Lash defines the amount of backlash in the simulated valve. It is defined in units of percentage of the full travel of the valve.

Load_Distb (LD)

Load_Distb can be used to simulate a disturbance load, such as a heat loss, which is added directly to the Input to the function block.

Time_Scaler (TS)

Time_Scaler acts as a scaler on the first order lags of the function block. Setting Time_Scaler to 1 enables the simulation models to provide a real time representation of actual systems. Values less than 1 signify faster than real time and values greater than 1 represent systems slower than real time.

Process_Gn (PG)

Process_Gn is the steady state gain of the simulated process. The steady state values of Main_PV and Slave_PV will be equal to Valve_Pos Process_Gn, so it is important that the value of Process_Gn is selected to take account of both the span of the simulated control application and the gain of the process.

Load_Offset (LO)

Load_Offset has no function in the VP_Load function block. It has been included for future enhancement.

Load_Delay (DEL)

Load_Delay is only used when Load_Type is set to 3. It defines the length of the time delay which is included in the simulation model.

Sensor_Break (SBR)

When Sensor_Break is set to BREAK (1), the function block simulates a sensor break condition. In this state Main_PV ramps to 200 % and Slave_PV ramps to 0. When Sensor_Break is reset to No (0), normal load simulation will resume.

Initialise (INI)

Setting Initialise to Init (1) freezes the operation of the function block, with Main_PV and Slave_PV being held at constant values. On the leading edge of resetting Initialise from Init (1) to Run (0), Main_PV and Slave_PV be reset to zero and the simulation will resume.

Invert_Load (IL)

Invert_Load has no function in the VP_Load function block. It has been included for future enhancement.

Main_PV (PV)

Main_PV is the simulated main process value (i.e. simulated temperature) of the function block.

Slave_PV (SPV)

Slave_PV is an intermediate process value, which is taken from the output of an intermediate lag in the simulation model. It is intended for use in master / slave cascaded control loop simulations.

Valve_Pos (VP)

Valve_Pos indicates the position of the simulated valve.

Parameter Attributes

Name	Type	Cold Start	Read Access	Write Access	Type Specific Information	
Back_Lash	**REAL**	1%	Oper	Oper	High Limit Low Limit	100% 0
Cool_Gain	**REAL**	1	Oper	Oper	High Limit Low Limit	10 0.1
Initialise	**BOOL**	Run (0)	Config	Config	Senses	Run (0) Init (1)
Invert_Load	**BOOL**	No (0)	Config	Config	Senses	No (0) Yes (1)
Load_Delay	**TIME**	0	Oper	Oper	High Limit Low Limit	25s 0
Load_Distb	**REAL**	0	Oper	Oper	High Limit Low Limit	10 0
Load_Offset	**REAL**	0	Oper	Oper	High limit Low Limit	100 -100
Load_Type	**DINT**	1	Oper	Oper	High Limit Low Limit	3 1
Lower	**BOOL**	Off (0)	Oper	Oper	Senses	Off (0) On (1)
Main_PV	**REAL**	0	Oper		High Limit Low Limit	10,000 -10,000
Process_Gn	**REAL**	1	Oper	Oper	High Limit Low Limit	100 0.1
Raise	**BOOL**	Off (0)	Oper	Oper	Senses	Off (0) On (1)
Sensor_Break	**BOOL**	No (0)	Oper	Oper	Senses	No (0) Break (1)
Slave_PV	**REAL**	0	Oper		High Limit Low Limit	10,000 -10,000
Time_Scaler	**REAL**	1	Oper	Oper	High Limit Low Limit	30 0.3
Travel_Time	**TIME**	10s	Oper	Oper	High Limit Low Limit	16m_40s 0
Valve_Pos	**REAL**	0	Oper		High Limit Low Limit	100 % 0

Table 25-4 VP_Load Parameter Attributes