Firmware Tde Macno

User's manual

Pid Pressure application n°2

Cod. MW00501E00 V_1.1 (ex. MAMODEZ010E0)

INDEX

VERSION APPLICATION 2.11

The application PID Pressure for OPDExp, controls a motor coupled to a hydraulic pump. The driver OPDExp machine control electronics receives a reference pressure and speed and a transducer mounted on the pipe line, reads the current pressure.

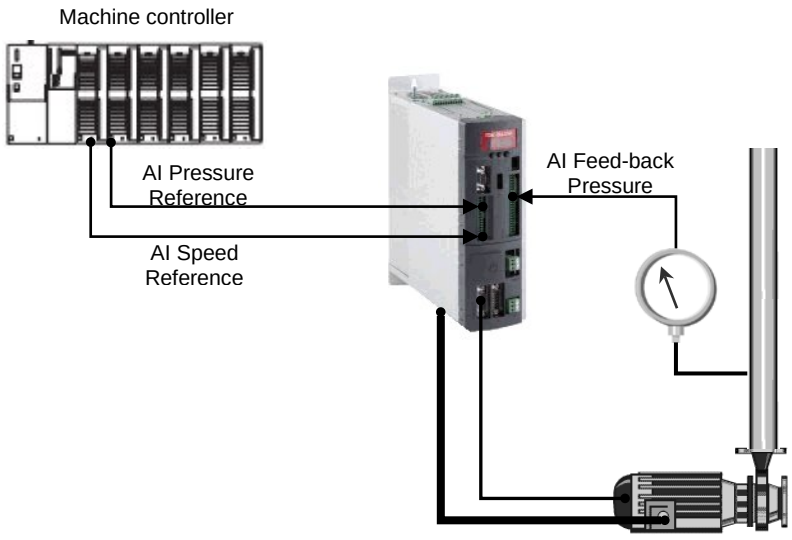


Figure 1: PID Pressure application

An application of the PID Pressure can be, for example a control of the plastics-injection for particular machines. In this case the PID Pressure realise a pressure control with speed control.

1 CONNECTION TEST, AUTOTUNING AND QUICK-START UP FOR PID PRESSURE

Enable quick- start up before enable both test.
Test connection and autotuning must be performed with the pump without oil. The motor in both test runs with a very slow speed for a few number of turn.
When connection test and autotuning finishes oil can be inserted, and then is possible to enable the speed test. Is important insert oil before speed test because otherwise this can cause damage at the pump.

1.1 APPLICATION DATA AND INTERNAL DISPLAY

Name	Description	UM	Default	Min	Max	Scale
LI1_SEL	C01 - Meaning of logic input 1		8	-1	31	1
LI2_SEL	C02 - Meaning of logic input 2		2	-1	31	1
LI3_SEL	C03 - Meaning of logic input 3		3	-1	31	1
LI4_SEL	C04 - Meaning of logic input 4		0	-1	31	1
LI5_SEL	C05 - Meaning of logic input 5		4	-1	31	1
LI6_SEL	C06 - Meaning of logic input 6		12	-1	31	1
LI7_SEL	C07 - Meaning of logic input 7		5	-1	31	1
LI8_SEL	C08 - Meaning of logic input 8		22	-1	31	1
LO1_SEL	C10 - Meaning of logic output 1		3	-64	63	1
LO2_SEL	C11 - Meaning of logic output 2		0	-64	63	1

Name	Description	UM	Default	Min	Max	Scale
LO3_SEL	C12 - Meaning of logic output 3		6	-64	63	1
LO4_SEL	C13 - Meaning of logic output 4		2	-64	63	1
AO1_SEL	C15 - Meaning of programmable analog output 1		11	0	99	1
AO2_SEL	C16 - Meaning of programmable analog output 2		4	0	99	1
EN_AI1	E00 - Enable analog reference value A.I.1		0			1
EN_AI2	E01 - Enable analog reference value A.I.2		0			1
EN_AI3	E02 - Enable analog reference value A.I.3		0			1
AI1_SEL	E03 - Meaning of analog input A.I.1		0			1
AI2_SEL	E04 - Meaning of analog input A.I.2		1			1
AI3_SEL	E05 - Meaning of analog input A.I.3		2			1
TF_TRQ_REF_AN	E06 - Filter time constant for analog torque reference value	ms	10	0.0	20.0	10
EN_SAV_ENR	E07 - Enable Save energy function		0			1
WND_SP_PID_SAV_ENR	E08 - Windows PID Setpoint enable save energy	%	0.0	-29.99	29.99	163.84
WND_MAN_PID_SAV_ENR	E09 - Windows PID Manual reference enable save energy	%	0.0	-29.99	29.99	163.84
TIME_DLY_SAV_ENR	E10 - Time delay enable save energy	ms	0	0	19999	1
PRC_SPD_JOG	E11 - Digital speed reference value (JOG1)	% MOT_SPD_MAX	0	-100.00	100.00	163.84
EN_SPD_JOG	E12 - Enable jog speed reference		0			1
SEL_LMN_MAX_OUT_PID	E13 - Meaning of Reference Limit Max Output PID		0			1
BSC_SP_PID	E14 - Basic Running of Setpoint PID	%	4.50	0.00	10.00	100
BSC_MAN_PID	E15 - Basic Running of Manual Setpoint PID	%	5.00	0.00	10.00	100
BSC_TIME_ZERO_REF	E16 - Basic Running Time Command Zero Reference	ms	0	0	1000	1
EXT_BSC_DLY	E17 - Exit Basic Running Delay Time	ms	0	0	1000	1
EN_ALR_BSC_FDK	E18 - Enable Alarm Feedback Pressure Not Reached		0			1
DLY_ALR_BSC_FDK	E19 - Delay Alarm Feedback Pressure Not Reached	s	60.0	0.1	200.0	1
PUMP_CC	E20 - Pump Capacity	cc	45.0	1.0	699.9	10
THR_BSC_SP_PID	E21 - Enable Threshold Basic Running of Setpoint PID	%	0.70	0.00	10.00	100
THR_BSC_MAN_PID	E22 - Enable Threshold Basic Running of Manual Setpoint PID	%	0.70	0.00	10.00	100
MAX_PV_DSP	E23 - Maximum Feedback Pressure for Display Scaling	Bar	250.00	0.00	327.67	100
WDOG_FLDBUS	E24 - Field Bus Watch dog Comunication	ms	0	0	19999	1
SPD_FF_TF	E25 - Speed Feed-Forward Filter time constant	ms	0.4	0.0	1999.9	10
EN_SPD_FF_4	E26 - Enable Speed Feed-Forward Filter 4° Order		0			1
PID_EN_THR	E27 - PID Enable Error Threshold Dynamic	%	20	0	1999	1
PID_EN_HST_MAX	E28 - PID Enable Hister Max Dynamic (Add to PID_EN_THR)	% (+PID_EN_THR)	20.00	0.00	300.00	100
PID_DS_END_THR	E29 - PID Disable End Threshold	%	2.00	0.00	3000.0	100
PRS_ERR_HST_TF	E30 – Pid disable End Threshold Filter time constant	ms	50.0	0.0	1999.9	10
ERR_THR_ENB_PID_TF	E31 - Error Enabled PID Threshold Filter time constant	ms	0.4	0.0	1999.9	10
PV_NOTCH1_F0	E32 - Notch Filter1 natural frequency of Feedback PID	Hz	50.0	0.0	1000.0	10

Name	Description	UM	Default	Min	Max	Scale
PV_NOTCH1_FB	E33 - Notch Filter1 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
THR_PUMP_PRT_OFF	E34 - Threshold Pump Protection (Reset Timer)	%	10.0	0.0	199.99	100
MAX_SP_DSP	E35 - Maximum Setpoint Pressure for Display Scaling	Bar	160.00	0.00	327.67	100
EN_LIN_RAMP	E36 - Enable linear ramp		0			1
EN_INV_SPD_REF	E37 - Invert reference signal software		0			1
EN_CTRL_TRQ	E38 - Enable only current control		0			1
PV_NOTCH1_DMP	E39 - Notch filter1 damping factor	%	0.0	0.0	100.0	10
EN_POS_REG_MEM_CLR	E40 - Enable overlapped space loop memory clear in stop		0			1
EN_SPD_FF	E41 - Enable Speed Feed-forward		0			1
PRS_START_TIME	E42 - Pressure Start Up Time	ms	80	1	19999	1
THR_PUMP_PRT_ON	E43 - Threshold Pump Protection (Start Timer)	%	100.0	0.0	199.99	100
DLY_PUMP_PRT	E44 - Delay Time Pump Protection	s	30.0	0.1	999.9	10
SP_MOT_TEMP_FAN	E45 - Motor Temperature for Command Fan Cooling	°C	60	1	200	1
HST_MOT_TEMP_FAN	E46 - Hysteresis Motor Temperature for Command Fan Cooling	°C	2	0	19	1
EN_FLDBUS_REF	E47 - Enable FIELD-BUS reference values		0			1
SP_I_THR_FAN	E48 - Motor thermal current for Command Fan Cooling	% ALL_I_THR	50.00	0.00	100.00	40.96
HST_I_THR_FAN	E49 - Hysteresis Motor thermal current for Command Fan Cooling	% ALL_I_THR	5.00	0.00	50.00	40.96
EN_DGT_SP_PID	E50 - Enable Digital Setpoint PID		0			1
DGT_SP_PID	E51 - Digital Setpoint PID	%	0.00	-300.00	300.00	100
SCL_IN_MIN_SP_PID	E52 - Scaling IN Min Value of Setpoint PID	%	0.00	-300.00	300.00	100
SCL_IN_MAX_SP_PID	E53 - Scaling IN Max Value of Setpoint PID	%	100.00	-300.00	300.00	100
SCL_OUT_MIN_SP_PID	E54 - Scaling OUT Min Value of Setpoint PID	%	0.00	-300.00	300.00	100
SCL_OUT_MAX_SP_PID	E55 - Scaling OUT Max Value of Setpoint PID	%	100.00	-300.00	300.00	100
ACC_SP_PID	E56 - Acceleration time Setpoint PID	ms	0	0	19999	1
DEC_SP_PID	E57 - Deceleration time Setpoint PID	ms	0	0	19999	1
SCL_IN_MIN_PV_PID	E58 - Scaling IN Min Value of Feed-Back PID	%	0.00	-300.00	300.00	100
SCL_IN_MAX_PV_PID	E59 - Scaling IN Max Value of Feed-Back PID	%	100.00	-300.00	300.00	100
SCL_OUT_MIN_PV_PID	E60 - Scaling OUT Min Value of Feed-Back PID	%	0.00	-300.00	300.00	100
SCL_OUT_MAX_PV_PID	E61 - Scaling OUT Max Value of Feed-Back PID	%	100.0	-300.00	300.00	100
TYP_SWT_MOD_PID	E62 - Type of switch mode PID Control		0			1
EN_DGT_MAN_PID	E63 - Enable Digital Manual Setpoint PID Output		0			1
DGT_MAN_PID	E64 - Digital Manual Setpoint PID Output	%	0.00	-300.00	300.00	100
SCL_IN_MIN_MAN_PID	E65 - Scaling IN Min Value of Manual Setpoint PI	%	0.00	-300.00	300.00	100
SCL_IN_MAX_MAN_PID	E66 - Scaling IN Max Value of Manual Setpoint PID	%	100.00	-300.00	300.00	100
SCL_OUT_MIN_MAN_PID	E67 - Scaling OUT Min Value of Manual Setpoint PID	%	0.00	-300.00	300.00	100
SCL_OUT_MAX_MAN_PID	E68 - Scaling OUT Max Value of Manual Setpoint PID	%	100.00	-300.00	300.00	100
ACC_MAN_PID	E69 - Acceleration Time of Manual Setpoint PID	ms	0	0	19999	1
DEC_MAN_PID	E70 - Deceleration Time of Manual Setpoint PID	ms	0	0	19999	1

Name	Description	UM	Default	Min	Max	Scale
FLWO_SPD_FF_TF	E71 - Derivative Flow observer Speed Filter time constant	ms	0.4	0.0	1999.9	10
PRC_PRESET_I	E72 - Preset Integral Part	% MAN_PID	100.00	0.00	199.99	100
EN_REF_PID	E73 - Enable reference from Output PID		0			1
LMN_MIN_KI_PID	E74 - Limit Min Value of Component KI PID	%	-100.00	-300.00	300.00	100
LMN_MAX_KI_PID	E75 - Limit Max Value of Component KI PID	%	100.00	-300.00	300.00	100
LMN_MIN_OUT_PID	E76 - Limit Min value of output PID	%	-100.00	-300.00	300.00	100
LMN_MAX_OUT_PID	E77 - Limit Max value of output PID	%	100.00	-300.00	300.00	100
SCL_IN_MIN_OUT_PID	E78 - Scaling IN Min Value of Output PID	%	0.00	-300.00	300.00	100
SCL_IN_MAX_OUT_PID	E79 - Scaling IN Max Value of Output PID	%	100.00	-300.00	300.00	100
SCL_OUT_MIN_OUT_PID	E80 - Scaling OUT Min Value of Output PID	%	0.00	-300.00	300.00	100
SCL_OUT_MAX_OUT_PID	E81 - Scaling OUT Max Value of Output PID	%	100.00	-300.00	300.00	100
TF_PID_ERROR	E82 - Filter time constant ERROR PID	ms	0.4	0.0	20.0	10
THR_LIN_KP	E83 - PID Error Threshold Enable Linear KP	% PID_Error	199.99	0.00	200.00	100
KP_PID	E84 - KP PID proportional gain		1.00	-327.67	327.67	100
TI_PID	E85 - TI PID Integral time	ms	0	0	19999	1
TD_PID	E86 - TD PID Derivative time	ms	0	0	19999	1
PV_NOTCH2_F0	E87 - Notch Filter2 natural frequency of feed-back PID	Hz	50.0	0.0	1000.0	10
PV_NOTCH2_FB	E88 - Notch Filter2 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
PV_NOTCH2_DMP	E89 - Notch Filter2 damping factor	%	0.0	0.0	100.0	10
TD_PID_1	E90 - Derivative time Flow observer	ms	0.00	-199.99	199.99	100
EN_AI4	E91 - Enable analog reference value A.I.4		0			1
AI4_SEL	E92 - Meaning of analog input A.I.4					1
OBSERVER_BW	E93 - Pression Observer bandwidth	Hz	0	0.0	1000.0	10
KP_HYD_FRCT	E94 - KP Hydraulic Friction		0.00	0.00	9.99	100
PV_NOTCH3_F0	E95 - Notch Filter3 natural frequency of Feed-back PID	Hz	50.0	0.0	1000.0	10
PV_NOTCH3_FB	E96 - Notch Filter3 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
PV_NOTCH3_DMP	E97 - Notch filter3 damping factor	%	0.0	0.0	100.0	10
REF_AI1	D64 - Reference from Analog Input AI1	%				163.84
REF_AI2	D65 - Reference from Analog Input AI2	%				163.84
REF_AI3	D66 - Reference from Analog Input AI3	%				163.84
ACT_PV_PID_NOT_FLT	D67 - Actual Feed-back PID (Not Filtered)	%				40.96
PRC_T_REF_AN	D68 - Analog Torque reference from Applica-tion	% MOT_SPD_MAX				40.96
PRC_T_REF_FLDBUS	D69 - Fieldbus Torque reference	% MOT_T_NOM				40.96
PRC_T_MAX_AN	D70 - Analog Torque Max from Application	% MOT_T_NOM				40.96
PRC_T_MAX_FLDBUS	D71 - Fieldbus Torque Max reference	% MOT_T_NOM				40.96
PRC_SPD_TOT_AN	D72 - Speed reference from AI1 + AI2 + AI3	% MOT_SPD_MAX				163.84
T_PV_PRT_PUMP	D73 - Timer Feedback Protection Pump	Sec				16
PRC_SPD_REF_FLDBUS	D75 - Fieldbus Speed reference	% MOT_SPD_MAX				163.84

Name	Description	UM	Default	Min	Max	Scale
PRC_SPD_REF_JOG	D76 - Jog Speed reference	% MOT_SPD_MAX				163.84
REF_AI4	D77 - Reference from Analog Input AI4					
ACT_MAN_PID_AFT_SCL	D79 - Actual Manual Setpoint PID before scaling	%				40.96
ACT_SP_PID_AFT_SCL	D80 - Actual Setpoint PID after scaling	%				40.96
ACT_SP_PID_BFR_SCL	D81 - Actual Setpoint PID befor scaling	%				40.96
ACT_SP_PID_BFR_RMP	D82 - Actual Setpoint PID befor ramp	%				40.96
ACT_SP_PID	D83 - Actual Setpoint PID	%				40.96
ACT_PV_PID_BFR_SCL	D84 - Actual Feed-back PID befor scaling	%				40.96
ACT_PV_PID	D85 - Actual Feed-back PID (Filtered)	%				40.96
ACT_MAN_PID_BFR_SCL	D86 - Actual Manual Setpoint PID befor scaling	%				40.96
ACT_MAN_PID_BFR_RMP	D87 - Actual Manual Setpoint PID befor ramp	%				40.96
ACT_MAN_PID	D88 - Actual Manual Setpoint PID	%				40.96
ACT_COM_P_PID	D89 - Actual Componente P of PID	%				40.96
ACT_COM_I_PID	D90 - Actual Componente I of PID	%				40.96
ACT_COM_D_PID	D91 - Actual Componente D of PID	%				40.96
ACT_OUT_PID	D93 - Actual Output PID	%				40.96
ACT_OUT_PID_SCL	D94 - Actual Output PID scaled	%				40.96
PRC_SPD_REF_PID	D95 - Actual Speed reference from PID	%				40.96
ACT_ERR_PID	D96 - Actual Errore SP-PV of PID	%				40.96
ACT_LIM_MAX_PID	D103 - Actual Limit Max Output PID	%				40.96
ACT_LIM_MIN_PID	D104 - Actual Limit Min Output PID	%				40.96
ACT_PUMP_FLW	D105 - Actual Pump Flow	l/min				40.96
ACT_PV_DSP	D106 - Actual Feed-back Pressure (Scaled)	Bar				40.96
ACT_EST_PV	D107 - Actual Estimated Feed-back	%				40.96
ACT_SPD_FDW_UNFLT	D108 - Actual Speed Feed-Forward Not Filtered	%				40.96
ACT_SPD_FDW	D109 - Actual Speed Feed-Forward	%				40.96
ACT_SP_DSP	D110 - Actual Setpoint Pressure (Scaled)	Bar				40.96
INIT_PAR	Init Drive OK (Obj 0x2050)		0	0	19999	1
STS_WORD	Status Word (Obj 0x2051)		0			1
ACT_POS_INJ	Actual Injection Position	mm				10
INJ_SPD_0	SP Speed Ref. Injection [0]	%	10	0	300.00	100
INJ_PRS_0	SP Pressure Ref. Injection [0]	%	0	0	300.00	100
INJ_POS_0	SP Position Injection [0]	mm	0	-2999.9	2999.9	10
INJ_SPD_1	SP Speed Ref. Injection [1]	%	0	0	300.00	100
INJ_PRS_1	SP Pressure Ref. Injection [1]	%	0	0	300.00	100
INJ_POS_1	SP Position Injection [1]	mm	0	-2999.9	2999.9	10
INJ_SPD_2	SP Speed Ref. Injection [2]	%	0	0	300.00	100
INJ_PRS_2	SP Pressure Ref. Injection [2]	%	0	0	300.00	100
INJ_POS_2	SP Position Injection [2]	mm	0	-2999.9	2999.9	10
INJ_SPD_3	SP Speed Ref. Injection [3]	%	0	0	300.00	100
INJ_PRS_3	SP Pressure Ref. Injection [3]	%	0	0	300.00	100
INJ_POS_3	SP Position Injection [3]	mm	0	-2999.9	2999.9	10
INJ_SPD_4	SP Speed Ref. Injection [4]	%	0	0	300.00	100
INJ_PRS_4	SP Pressure Ref. Injection [4]	%	0	0	300.00	100
INJ_POS_4	SP Position Injection [4]	mm	0	-2999.9	2999.9	10
HLD_SPD_0	SP Speed Ref. Holding [0]	%	0	0	300.00	100
HLD_PRS_0	SP Pressure Ref. Holding [0]	%	0	0	300.00	100
HLD_TIME_0	SP Time Holding [0]	ms	0	0	19999	1
HLD_SPD_1	SP Speed Ref. Holding [1]	%	0	0	300.00	100
HLD_PRS_1	SP Pressure Ref. Holding [1]	%	0	0	300.00	100
HLD_TIME_1	SP Time Holding [1]	ms	0	0	19999	1

Name	Description	UM	Default	Min	Max	Scale
HLD_SPD_2	SP Speed Ref. Holding [2]	%	0	0	300.00	100
HLD_PRS_2	SP Pressure Ref. Holding [2]	%	0	0	300.00	100
HLD_TIME_2	SP Time Holding [3]	ms	0	0	19999	1
HLD_SPD_3	SP Speed Ref. Holding [3]	%	0	0	300.00	100
HLD_PRS_3	SP Pressure Ref. Holding [3]	%	0	0	300.00	100
HLD_TIME_3	SP Time Holding [3]	ms	0	0	19999	1
HLD_SPD_4	SP Speed Ref. Holding [4]	%	0	0	300.00	100
HLD_PRS_4	SP Pressure Ref. Holding [4]	%	0	0	300.00	100
HLD_TIME_4	SP Time Holding [4]	ms	0	0	19999	1
SBCK_SPD_0	SP Speed Ref. Suck Back [0]	%	0	0	300.00	100
SBCK_PRS_0	SP Pressure Ref. Suck Back [0]	%	0	0	300.00	100
SBCK_POS_0	SP Position Suck Back [0]	mm	0	-2999.9	2999.9	10
SBCK_SPD_1	SP Speed Ref. Suck Back [1]	%	0	0	300.00	100
SBCK_PRS_1	SP Pressure Ref. Suck Back [1]	%	0	0	300.00	100
SBCK_POS_1	SP Position Suck Back [1]	mm	0	-2999.9	2999.9	10
OFFSET_POS_INJ	Offset Injection Position	mm	0	-3260.0	32600	10
ACT_SPD_INJ	Actual Injection Speed	mm				10
ACT_PRS_INJ	Actual Injection Pressure	Bar				10

1.2 ANALOG OUTPUT AND MONITORS VALUES

Osc	Description	UM	Scale
68	Threshold Enable PID	%	4096
69	Threshold Disable PID	%	4096
70	Actual Feed-back PID not filtered	%	4096
71	Actual Setpoint PID befor scaling	%	4096
72	Actual Setpoint PID befor ramp	%	4096
73	Actual Setpoint PID	%	4096
74	Actual Feed-back PID befor scaling	%	4096
75	Actual Feed-back PID (Filtered)	%	4096
76	Actual Manual Setpoint PID befor scaling	%	4096
77	Actual Manual Setpoint PID befor ramp	%	4096
78	Actual Manual Setpoint PID	%	4096
79	Actual Componente P of PID	%	4096
80	Actual Componente I of PID	%	4096
82	Derivate Flow Observer	%	4096
81	Actual Componente D of PID	%	4096
83	Actual Output PID	%	4096
84	Actual Output PID after scaling	%	4096
85	Actual Speed reference from PID	%	4096
86	Actual Errore SP-PV of PID	%	4096
90	Actual Limit Max Output PID	%	4096
91	Actual Limit Min Output PID	%	4096
92	Actual Pump Flow	l x 10 / min	1
93	Actual Estimated Feed-back	%	4096
94	Actual Speed Feed-Forward Not Filtered	%	4096
95	Actual Speed Feed-Forward	%	4096
98	Injection Actual Position	mm/10	1
99	Injection Actual Speed	mm10/s	1

1.3 INPUT LOGIC FUNCTIONS AND APPLICATION OUTPUT FUNCTIONS

INP	LOGIC FUNCTION ASSIGNED
I00	Run command
I01	Torque control
I02	Enable analog reference value AI1
I03	Invert analog reference value AI1
I04	Enable analog reference value AI2
I05	Invert analog reference value AI2
I06	Enable analog reference value AI3
I07	Invert analog reference value AI3
I08	Reset alarms
I09	Enable overheat protection pump
I10	Request injection (simulator)
I11	Request sucback (simulator)
I12	Invert speed reference value
I14	Enable FIELD-BUS reference values
I15	Enable analog reference value AI4
I16	Invert analog reference value AI4
I17	Enable speed jog
I22	Enable linear ramps
I23	Motor thermo-switch
I24	Freeze PI speed regulator integral memory
I25	Live from Master
I27	Enable Digital Setpoint PID
I28	Enable Automatic PID Control [0=Man]
I29	Enable reference from Output PID
I30	Enable Digital Manual Setpoint PID
I31	Enable simulator automatic cycle

1.4 APPLICATION OUTPUT FUNCTIONS

OUT	LOGIC FUNCTION ASSIGNED
O32	Fan Cooling
O33	Driver on save enegy
O34	PID Control Enabled
O35	Valve injection (Simulator)
O36	Valve suckback (Simulator)

1.5 ANALOG INPUT AND REFERENCE

There can be up to 3 differential analog inputs (A.I.1 ÷ A.I.16) ± 10V which, after being digitally converted with a resolution of 14 bits, can be:

- conditioned by digital offset (**P2-OFFSET_AI1** for A.I.1, **P4-OFFSET_AI2** for A.I.2 and **P6-OFFSET_AI3** for A.I.3) and a multiplicative coefficient (**P1-KP_AI1** for A.I.1, **P2-KP_AI2** for A.I.2 and **P3-KP_AI3** for A.I.3),
- enabled independently through configurable logic inputs (**I02- ID_EN_AI1** for A.I.1, **I04- ID_EN_AI2** for A.I.2 and **I06- ID_EN_AI3** for A.I.3) or connections (**E00-EN_AI1** for A.I.1, **E01-EN_AI2** for A.I.2 and **E02-EN_AI3** for A.I.3),
- configured as meaning through the corresponding connection (**E03-AI1_SEL** for A.I.1, **E04-AI2_SEL** for A.I.2 and **E05-AI3_SEL** for A.I.3),
- added together for the references with the same configuration.

1.5.1 ANALOG INPUT 1

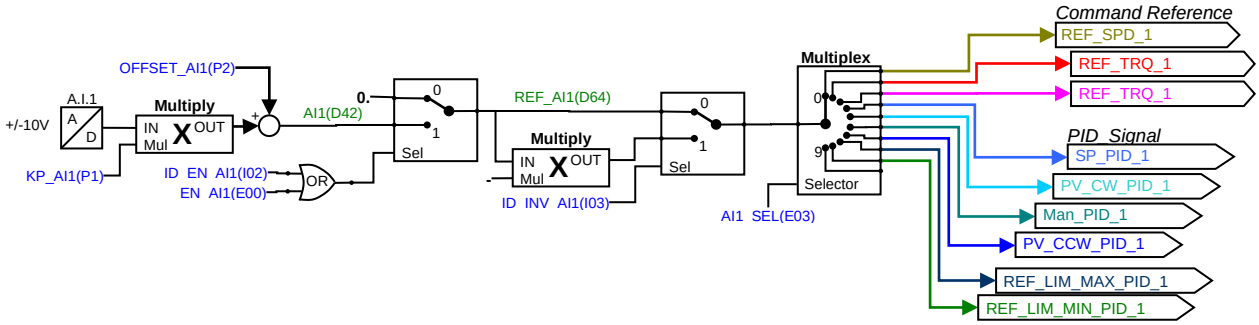


Figure 2: Analog input 1

1.5.2 ANALOG INPUT 2

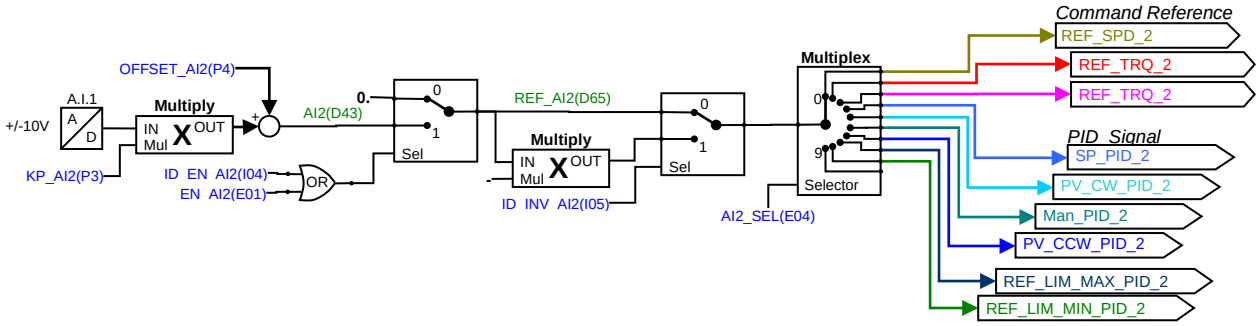


Figure 3: Analog input 2

1.5.3 ANALOG INPUT 3

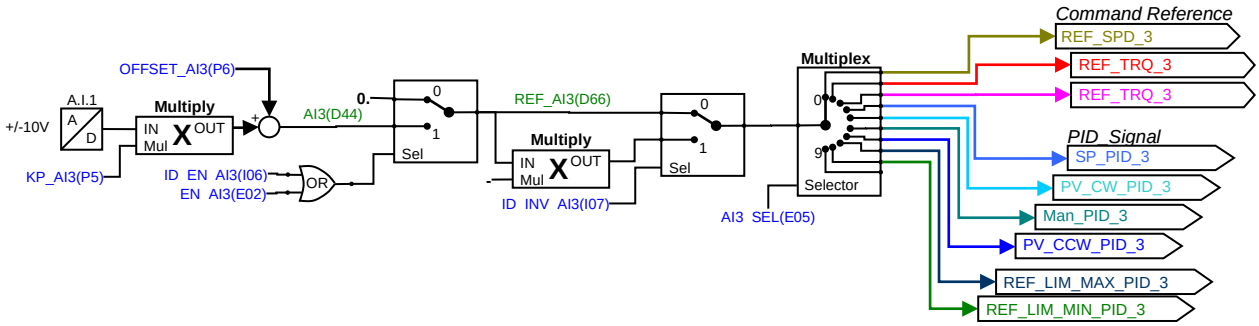


Figure 4: Analog input 3

1.5.4 ANALOG SPEED REFERENCE

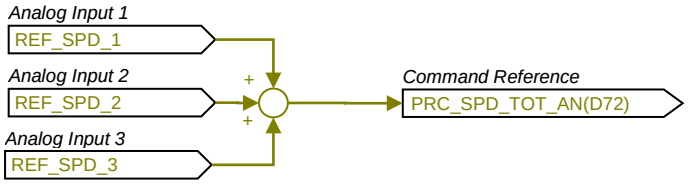


Figure 5: Analog speed reference

1.5.5 ANALOG TORQUE REFERENCE

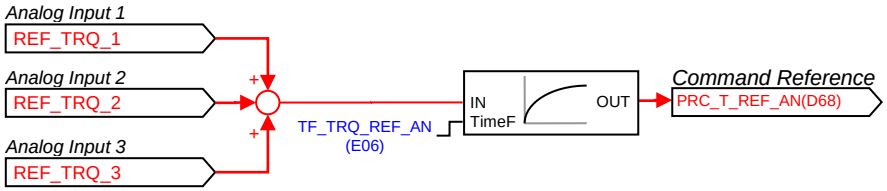


Figure 6: Analog torque reference

1.5.6 ABALOG TORQUE LIMIT REFERENCE

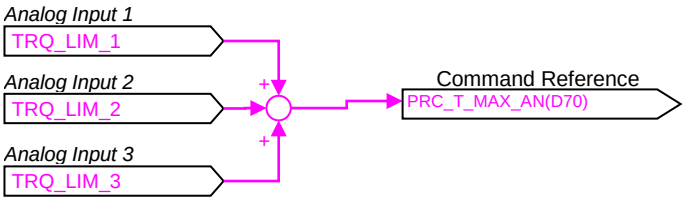


Figure 7: Analog torque limit reference

1.5.7 ANALOG REFERENCE

Schematic of Analog Input 1, Analog Input 2 and Analog Input 3 shows parameter,setting and configuration of analog inputs and references.As speed,torque and its limits concerns plus refer to the manual "Closed_loop_standard_option_V1.7_en_NEW.pdf".
Through parameters AI1_SEL (2 and 3) it is possible to configure analog inputs as speed ,torque ,torque limit,PID set point, PID feedback, PID manual reference and PID output limit. Signal with same configuration will be used in the reference addition block.
For realise a pressure control (with speed control) it's necessary to set, like analog input, the **pressure reference**, the **pressure feed-back** and the **speed reference.** The value of speed reference can be interpreted like a manual speed set-point when the PID control is not active. This is a limit speed value for the PID output.

1.6 PID REFERENCE INPUT

1.6.1 PID SET-POINT

This value can be the pressure set-point (SP) and comes from the particular analog input selected. For example can be the analog value output of the machine controller. The value can be scaled to adapt it at the feedback value pressure (PV). It's ncessary to chose one of the analog input (**E03-A1_SEL**, **E04-A2_SEL, E05-A3_SEL** or sum of plus refeence) with the meaning of SetPoint PID.

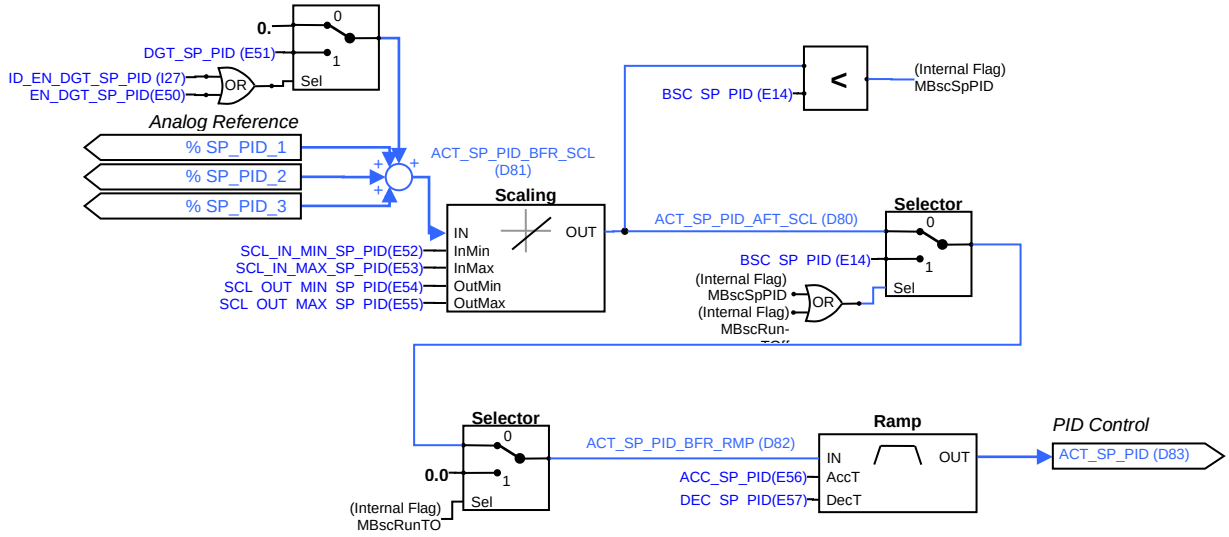


Figure 8: PID Set-point

1.6.2 PID FEED-BACK

This value can be the pressure feedback (PV) and comes from the particular analog input selected. For example can be the analog value output of the pressure transducer. The value can be scaled to adapt it at the set-point value pressure (SP).

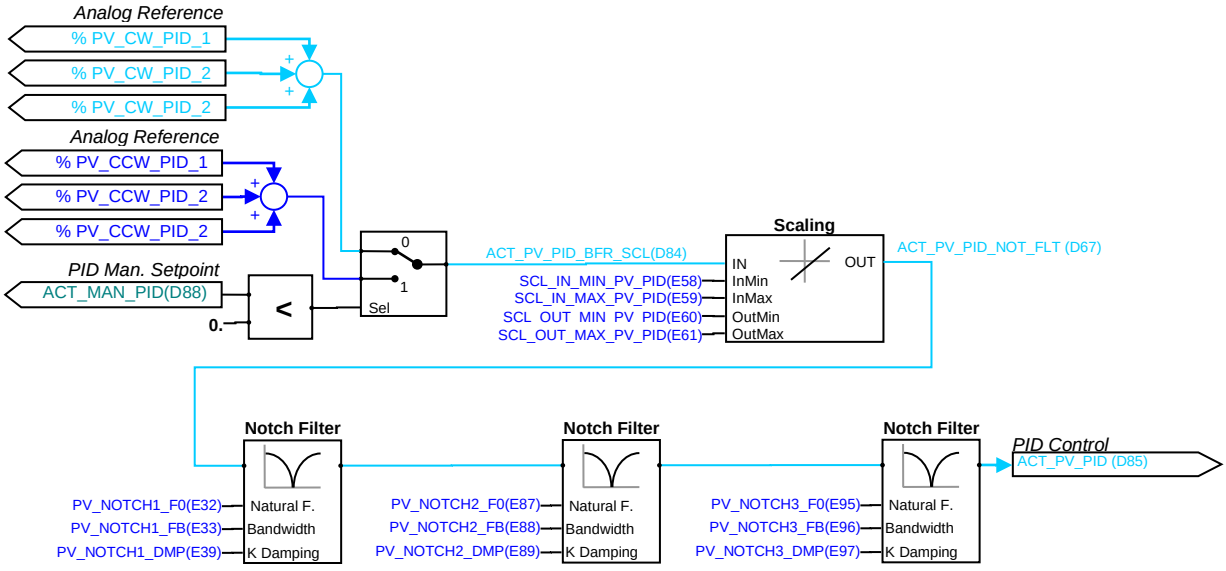


Figure 9: PID Feed-back

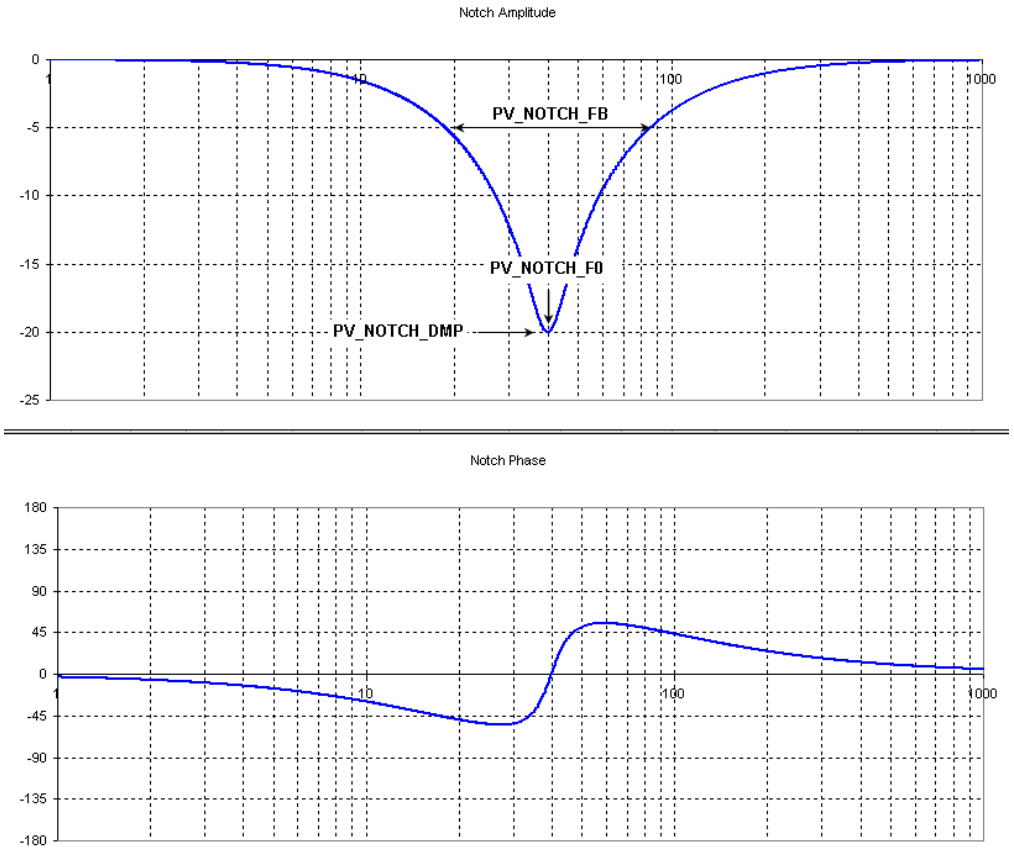
1.6.2.1 NOTCH FILTER ON PV

Starting from 2.10 revision it's possible to enable a notch filter that works on Pressure feedback.
The Notch Filter is implemented in the control system to reduce the effect of the mechanical/idraulic resonances of the plant, that limits the pressure control bandwidth.
To configure the filter are available three parameters:

Name	Description	UM	Default	Min	Max	Scale
PV_NOTCH1_F0	E32 - Notch Filter1 natural frequency of Feed-back PID	Hz	50.0	0.0	1000.0	10
PV_NOTCH1_FB	E33 – Notch Filter1 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
PV_NOTCH1_DMP	E39 - Notch filter1 damping factor	%	0.0	0.0	100.0	10
PV_NOTCH2_F0	E87 - Notch Filter2 natural frequency of Feed-back PID	Hz	50.0	0.0	1000.0	10
PV_NOTCH2_FB	E88 – Notch Filter2 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
PV_NOTCH2_DMP	E89 - Notch filter2 damping factor	%	0.0	0.0	100.0	10
PV_NOTCH3_F0	E95 - Notch Filter3 natural frequency of Feed-back PID	Hz	50.0	0.0	1000.0	10
PV_NOTCH3_FB	E96 – Notch Filter3 bandwidth of Feed-back PID	Hz	25.0	0.0	1000.0	10
PV_NOTCH3_DMP	E97 - Notch filter3 damping factor	%	0.0	0.0	100.0	10

The PV_NOTCH_F0 is the center filter frequency, the PV_NOTCH_FB is the filter bandwidth and the PV_NOTCH_DMP is the filter damping factor.

In order to enable the Notch filter is enough to set the PV_NOTCH_F0 different from zero.
To easy use of this filter is possible to set NOTCH_FREQ=NOTCH_BW=frequency to remove and PV_NOTCH_DMP=0.10.



1.6.3 PID MANUAL SET-POINT

This value can be the speed manual set point (manual SP) and comes from the particular analog input selected. This is the speed set-point when the PID controller is not active.

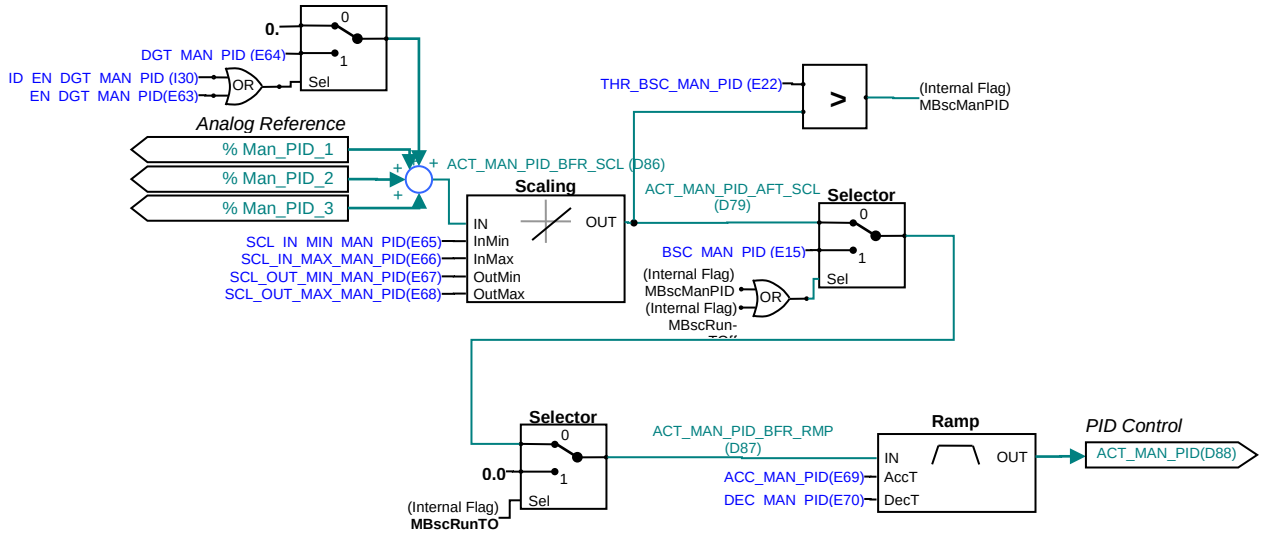


Figure 10: PID Manual Set-point

1.6.4 BASIC FUNCTION RUNNING

The basic running is a particolar function, developed after some machine demands that can act directly on pressure and speed (manual) set point. The function allows to set both set point with zero value for a programmable time when the function is activated (T_{on}) and when is disactivated (T_{off}). Figure 11 shows the behavior of the basic running function with the internal flag.

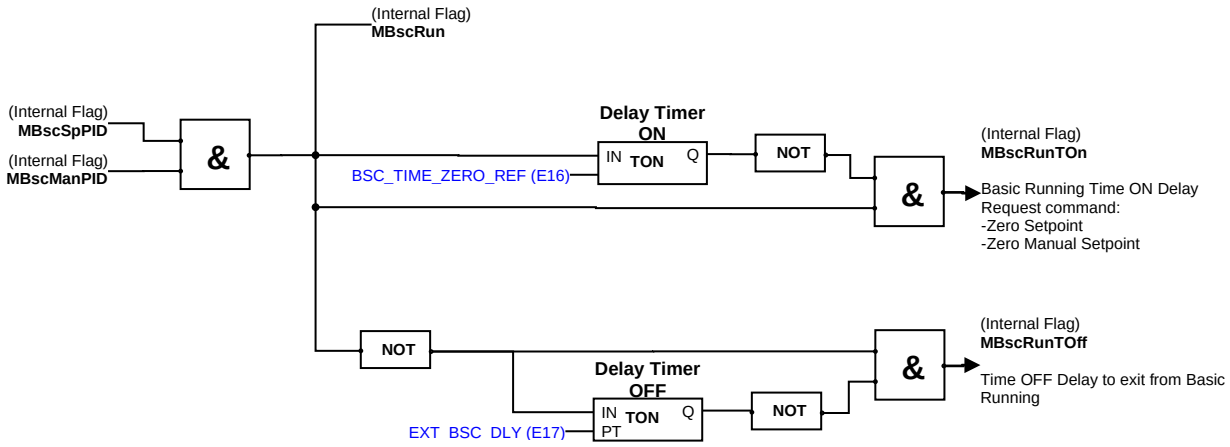


Figure 11: Basic running diagram

When internal flag **MBscSpPID** isTRUE the internal value of actual set point after scaling (**D80-ACT_SP_PID_AFTSCL**) is less than **E21-THR_BSC_SP_PID,** the flag will reset when the actual set point will be greather than **E21 + 0,1%**. Similarly the flag **MBscManPID** isTRUE when the internal value of actual manual set point after scaling (**D79-ACT_MAN_PID_AFTSCL**) is less than **E22-THR_BSC_MAN_PID**, the flag will reset when the actual set point will be greather than **E21 + 0,1%. MBscRun** is TRUE when both internal flags have TRUE value.
If only **MBscSpPID** has TRUE value, **MBscRun** remains at FALSE value and the set-point applicated is the value set in **E14-BSC_SP_PID**. Similarly If only **MBscManPID** has TRUE value, **MBscRun** remains at FALSE value and the set-point applicated is the value set in **E15-BSC_MAN_PID.**
When there is a rising-edge on **MBscRun** the TIMER ON is activated and **MBscRunTOn** goes to the high level, in this lapse zero value is applied for set-point and manual set-point. When the TIMER ON reaches the timer value limit set in **E16-BSC_TIME_ZERO_REF** flag **MBscRunTOn** goes to the low level and **E14-BSC_SP_PID** and **E16-BSC_MAN_PID** are applicated.

When there is a falling-edge on **MBscRun** (**MBscSpPID** or **MBscManPID** goes to the low level) the TIMER OFF is activated and **MBscRunTOff** goes to the high level, in this lapse **BSC_SP_PID** or **BSC_MAN_PID** are applied for set-point and manual set-point. When the TIMER OFF reaches the timer value limit set in **E17-EXT_BSC_DLY** flag **MBscRunTOff** goes to the low level.
It's possible to enable an application allarm (set **E18-EN_ALR_BSC_FDK**) if the pressure set point is not reached in the time **E19-DLY_ALR_BSC_FDK** when basic running is activated.
Figure 12 shows a basic running cycle with the following parameters:

- **E21-THR_BSC_SP_PID** = **E22-THR_BSC_MAN_PID** = 0.70%,
- **E14-BSC_SP_PID** = **E15-BSC_MAN_PID** = 4.50%,
- **E16-BSC_TIME_ZERO_REF** = 0 ms,
- **E17-EXT_BSC_DLY** = D ms

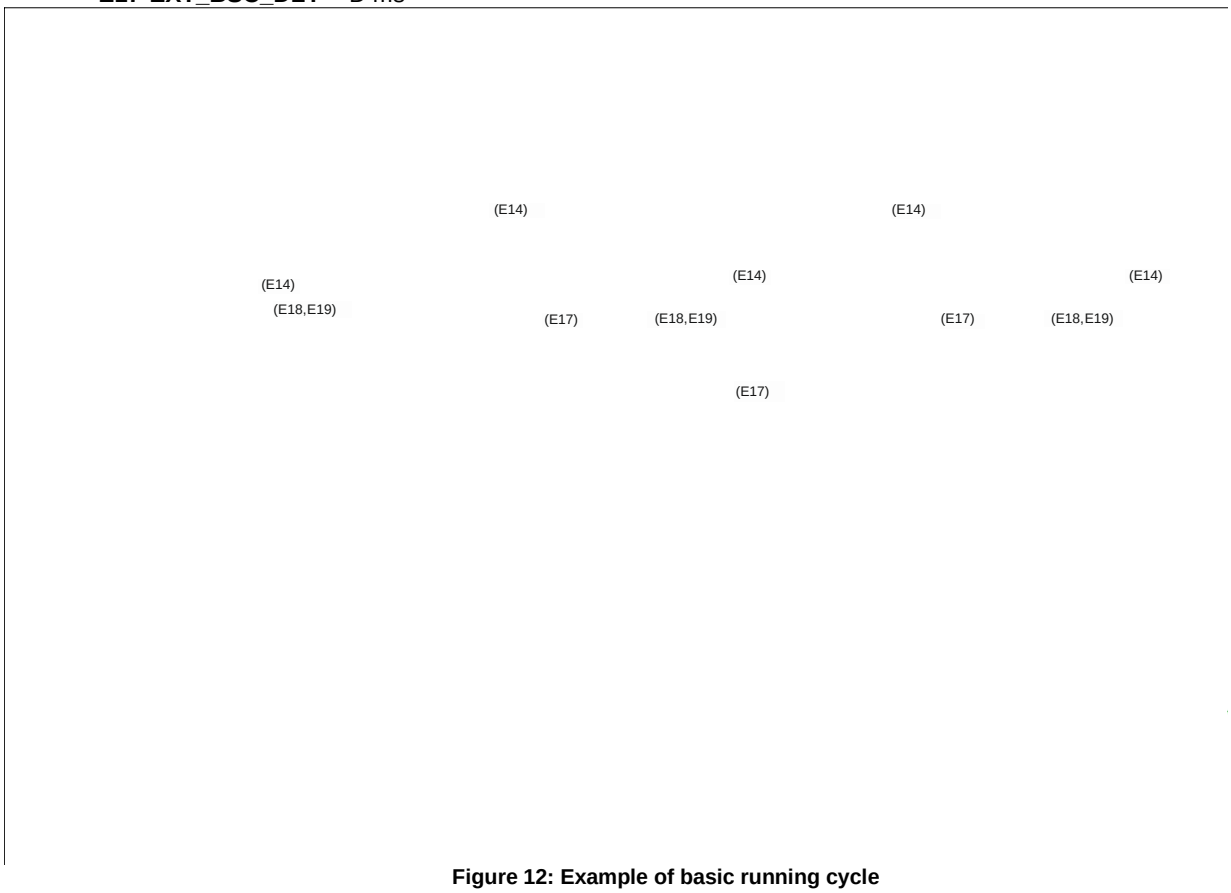


Figure 12: Example of basic running cycle

In the first time sector, the value pressure (or speed) is less than the respective threshold and the basic running function is actived. The pressure (or speed) reference has the value set in E14 (or E15), for this example 4.5%.
When the value of the second variable, speed (or pressure) goes under his threshold both input flag **MBscSpPID** and **MBscManPID** are in the high level and **MBscRun** is **TRUE**.
At the end of first time sector **MBscRun** goes to the low level and time-off basic running is activated and the time counter start. For this time the reference applied is **BSC_SP_PID** (or **BSC_MAN_PID**).

1.6.5 PID LIMIT OUTPUT

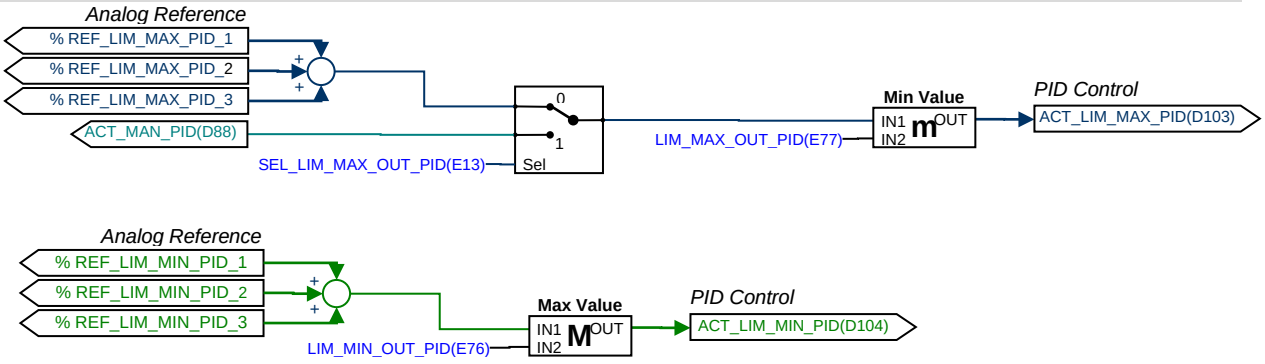


Figure 13: PID limit output

1.7 PID CONTROL

Setting the parameter **E62-TYP_SWT_MOD_PID** is possible to enable the operative mode of the PID control. The possible mode are:

0. From digital input,
1. Only manual,
2. Only automatic,
3. Auto: SP>PV, Manual: Out_PID>Man_Sp,
4. Auto: ERROR<THR, Man: ERROR>=THR+HST;

With the operative mode 4 the automatic mode is enable when actual error (SP-PV) is less than **E27-PRS_ERR_THR** and is disabled (manual mode) when error is greater than threshold + hysteresis value. The histeresis has no a fixed value but is filtered with a first order filter (time constant **E30-PRS_ERR_HST_TF**). The error is also filtered with time constant **E31-ERR_HST_TF**.

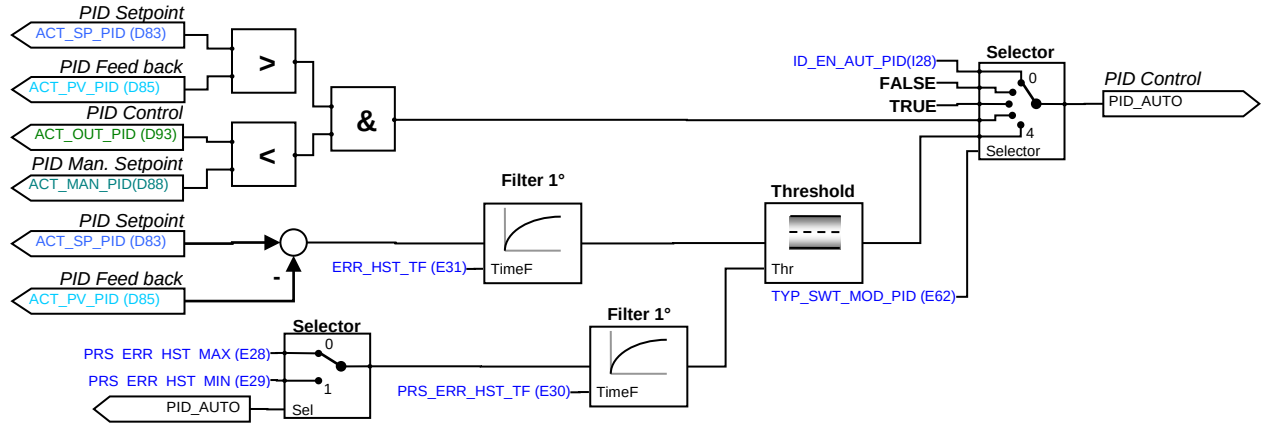


Figure 14: PID enable parameters

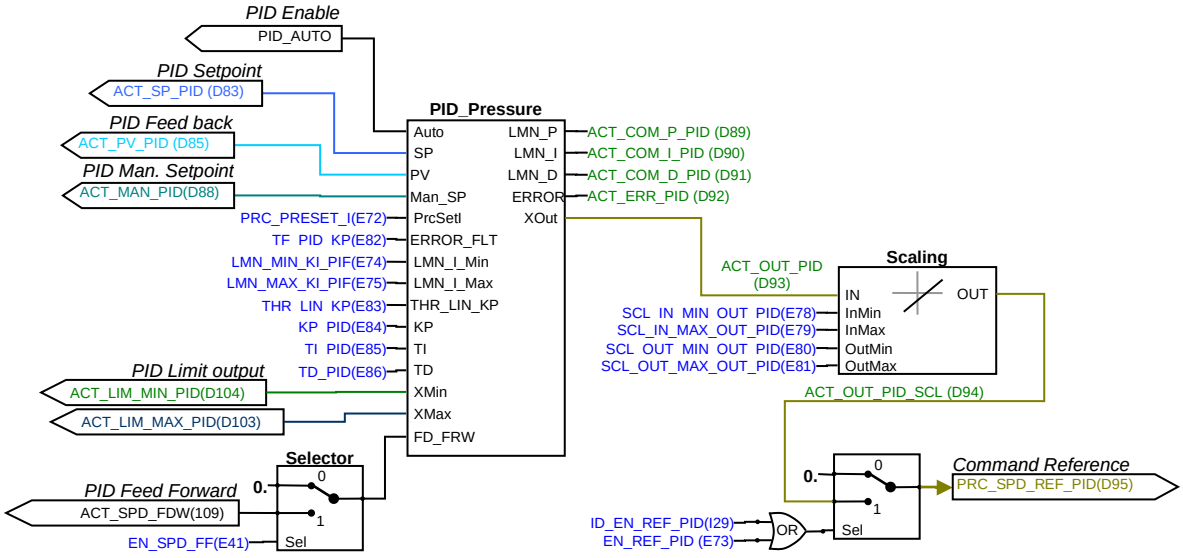


Figure 15: PID control parameters

1.7.1 PID PRESSURE

Here after are explained implemented PID function. Eventually a pressure Feed-Forward can be enable, setting the parameter **E41-EN_SPD_FF** to **Yes**.

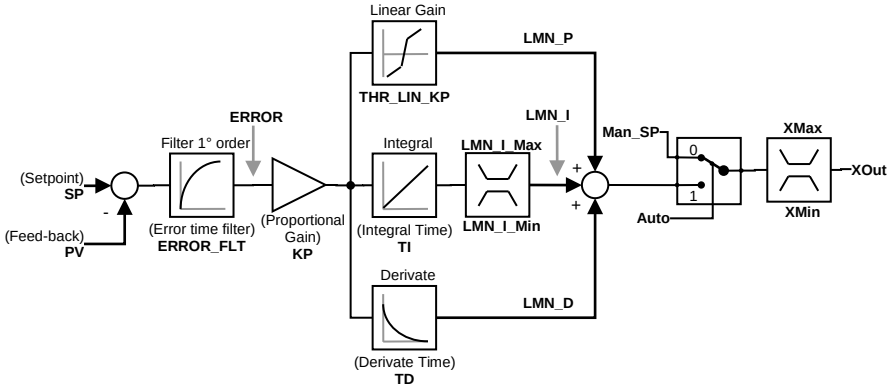


Figure 16: PID function

1.7.1.1 FLOW ESTIMATION MODEL

It's well proven that it's very important help the PID Pressure regulator with a feed-forward, equals to the flow.
In the control algorithm is available the process model in order to obtain the flow estimation.
This model is based on some parameters:

Name	Um	Description
EN_SPD_FF		E41 - Enable flow feed-forward term
OBSERVER_BW	Hz	E93 - Estimated Pressure Loop Bandwidth
PRS_START_TIME	ms	E42 - Time to reach the maximum pressure with maximum pump speed without losses
KP_HYD_FRCT		E94 - Pressure needed due to frictions in the hydraulic circuit
FLWO_SPD_FF_TF	ms	E71 - Speed filter time constant for derivative term
FLWO_TD	ms	E90 - Derivative time related to oil inertia
SPD_FF_TF	ms	E25 - Estimated Flow filter time constant
EN_SPD_FF_4		E26 - Enable Flow IV° filter

For achieve a good flow estimation it's important to set correctly the "PRS_START_TIME". This time is related to the pump and to hydraulic circuit, however it's better to set it to a low value (<20ms).

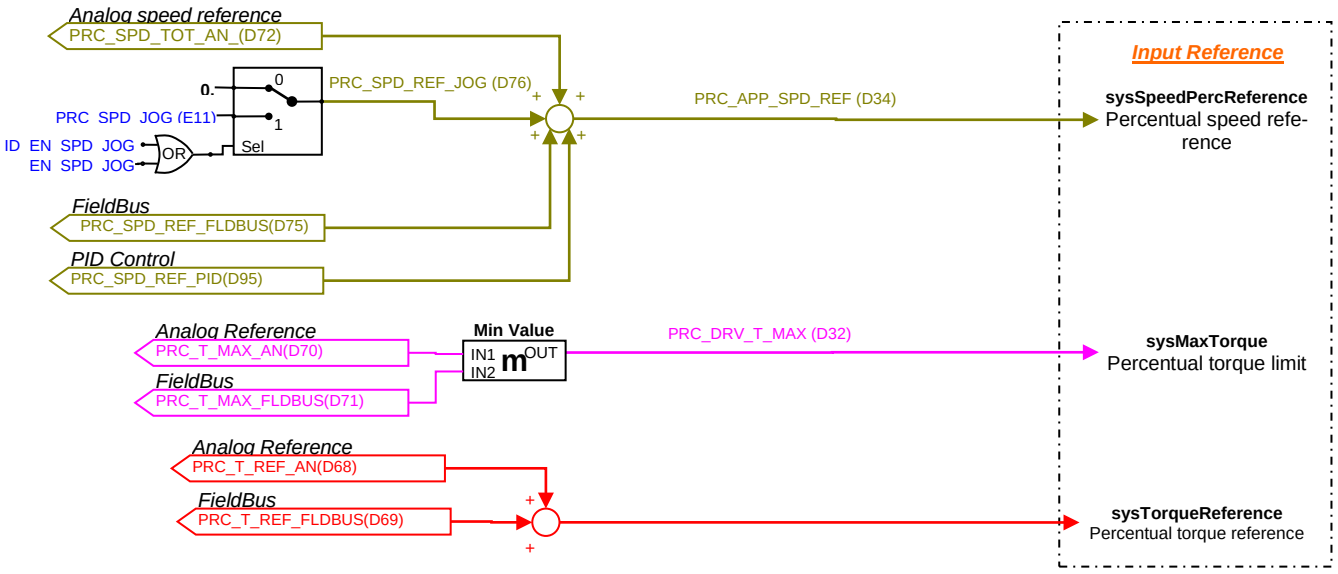
The "OBSERVER_BW" correct value is 250Hz.

The Frictions term ("KP_HYD_FRCT") is usually negligible, parameter can be set to 0.1 or less.

The Derivative term ("FLWO_TD") is usually negligible especially with low power machine, can be useful with medium or big machine. In the last cases, set "FLWO_SPD_FF_TF" about 1ms and "FLWO_TD" starting from 1ms.

Usually in the hydraulic circuit there may be some resonance frequencies: the best is to use the Notch Filter to cut the lower resonance and than filter the other resonances with "SPD_FF_TF". For example setting "SPD_FF_TF"=4ms and enabling the fourth order filter ("EN_SPD_FF_4") it's possible to cut frequencies over than 50Hz.

1.8 COMMAND REFERENCE



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