AC30V series
Pump Control Application

HA502134U001 Issue 3
Technical Manual

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climate control
electromechanical
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Pump Control Application

HA502134U001 Issue 3

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Pump Control Application Manual

Description

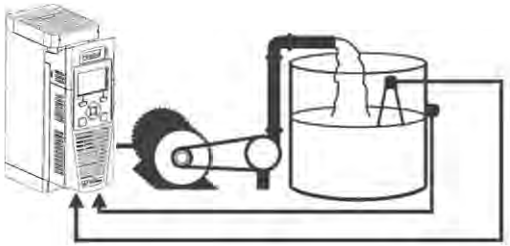
The pump application provides either flow control or speed control of a water pump.
In AUTO mode a flow feedback transducer is used to close the loop using a PID trim.
In MANUAL mode the requested pump speed is derived directly from the flow setpoint.
The calculated load is used to detect abnormal behaviour indicating blockage or leakage.
Feedback break input detection (4..20mA only).

Features

- Pump application specific menus and parameters
- Flow parameters and diagnostics in L/min
- PID flow control
- Automatic pump blockage and leakage detection (abnormal load)
- Power-up start

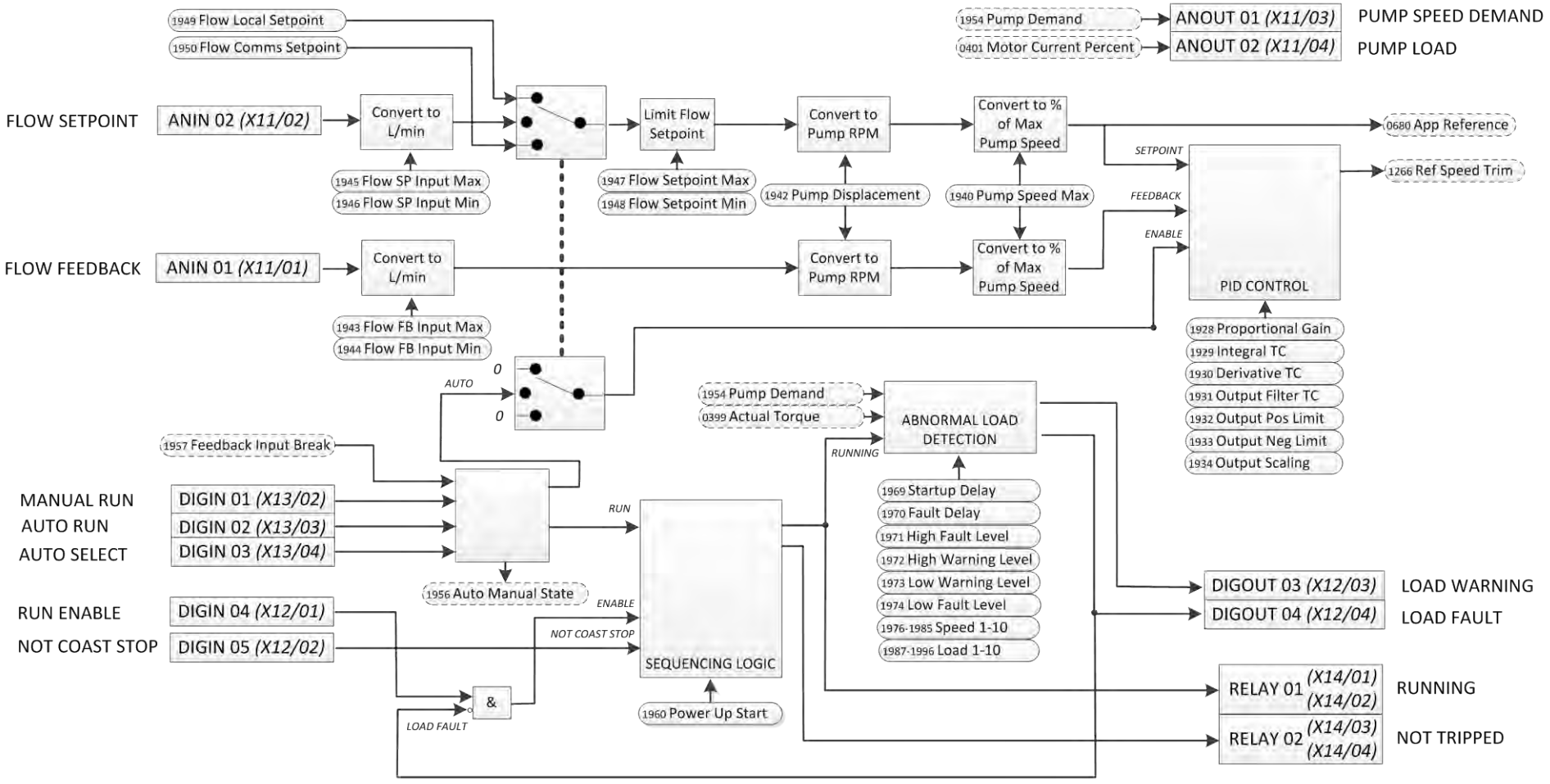
Requirements

To use the AC30V for pump control as described in this manual, the application RA502134U001 must be loaded into an AC30V series drive with firmware 1.3.1. or newer.



“Pump Control”

DEDICATED PUMP CONTROL WITH SPECIFIC PUMP FUNCTIONALITY



Inputs

Terminal	Function	Comment
ANIN 01 (X11/01)	FLOW FEEDBACK	Flow feedback input (0..10V, 0..20mA, 4..20mA)
ANIN 02 (X11/02)	FLOW SETPOINT	Flow setpoint input (0..10V)
DIGIN 01 (X13/02)	MANUAL RUN	Drive start with no PID control (speed control)
DIGIN 02 (X13/03)	AUTO RUN	Drive start with PID control (flow control)
DIGIN 03 (X13/04)	AUTO SELECT	Switch between AUTO and MANUAL modes
DIGIN 04 (X12/01)	RUN ENABLE	Auxiliary start signal
DIGIN 05 (X12/02)	NOT COAST STOP	Quench drive output
DIGIN 07 (X12/04)	Terminal used as DIGOUT 01	
DIGIN 06 (X12/03)	Terminal used as DIGOUT 02	

Outputs

Terminal	Function	Comment
ANOUT 01 (X11/03)	PUMP SPEED DEMAND	Pump speed demand as a percentage of maximum pump speed
ANOUT 02 (X11/04)	PUMP LOAD	Estimated load
RELAY 01 (X14/01 & X14/02)	RUNNING	When closed the pump is being driven
RELAY 02 (X14/03 & X14/04)	NOT TRIPPED	When closed the drive is not tripped
DIGOUT 01 (X12/01)	Terminal used as DIGIN 04	
DIGOUT 02 (X12/02)	Terminal used as DIGIN 05	
DIGOUT 03 (X12/03)	LOAD WARNING	Abnormal load (high or low) detection warning (blocked or leaking))
DIGOUT 04 (X12/04)	LOAD FAULT	Abnormal load (high or low) detection fault (blocked or leaking))

Graphical Keypad (GKP) Application Customisation

The pump application adds parameters and menus to the GKP. It also modifies the behaviour of the Control Screen and set-up wizard.

Control Screen	
In Remote (terminal or comms) mode	***In Local (GKP) mode***
1951: Flow Setpoint (L/min) 1952: Flow Feedback (L/min)	1949: Flow Local Setpoint (L/min) 1952: Flow Feedback (L/min)

Setup Wizard::Application menu
1940: Pump Speed Max (RPM) 1941: Pump Speed Min (RPM) 1942: Pump Displacement(L/rev) 1943: Flow FB Input Max (L/min) 1944: Flow FB Input Min (L/min) 1945: Flow SP Input Max (L/min) 1946: Flow SP Input Min (L/min) 1947: Flow Setpoint Max (L/min) 1948: Flow Setpoint Min (L/min) 1937: Disable Coast Stop 1960: Power Up Start

Quick Setup menu
1947: Flow Setpoint Max (L/min) 1948: Flow Setpoint Min (L/min) 1940: Pump Speed Max (RPM) 1941: Pump Speed Min (RPM) 0486: Acceleration Time (s) 0487: Deceleration Time (s) 1928: PID Proportional Gain 1929: PID Integral TC (s) 1934: PID Output Scaling 1932: PID Output Pos Limit (%) 1933: PID Output Neg Limit (%) 1006: Run Setup? 1141: View Level

Quick Monitor menu
1956: Auto Manual State 1997: Load Monitor State 1957: Feedback Input Break 1951: Flow Setpoint (L/min) 1952: Flow Feedback (L/min) 1954: Pump Demand (%) 1955: Actual Load (%) 1953: Flow Remote Setpoint (L/min) 1950: Flow Comms Setpoint (L/min) 1935: PID Output (%) 1936: PID Error (%) 1998: Expected Load (%) 1999: Load Error (%)

Setup::Application
Application Pump and Flow Sequencing PID Abnormal Load Detect App Selection

Monitor::Application
Application Pump and Flow Sequencing PID Abnormal Load Detect

Pump and Flow

Setup::Application::Pump and Flow
Monitor::Application::Pump and Flow*

Application specific parameters to setup and monitor the pump and flow. All flow parameters are in Litres per minute (L/min).

PNO	Parameter Descriptions
1940	**Pump Speed Max** This is the maximum speed in RPM that the pump can operate. It is the same as the **0464: 100% Speed in RPM** parameter.
1941	**Pump Speed Min** This is the minimum speed in RPM that the pump is allowed to operate. It sets the low limit for the speed demand when running.
1942	**Pump Displacement** This parameter sets the number of litres displaced by one revolution of the pump. It is used to convert setpoints and feedbacks given in litres per minute (L/min) to a pump speed in RPM.
1943	**Flow FB Input Max** This is the full range value in L/min for the Flow Feedback analogue input (ANIN01). It corresponds to the maximum input value of either 10V or 20mA depending on the setting of **0001: Anin 01 Type**.
1944	**Flow FB Input Min** This is the minimum value in L/min for the Flow Feedback analogue input (ANIN01). It corresponds to the minimum input value of either 0V, 0mA or 4mA depending on the setting of **0001: Anin 01 Type**.
1945	**Flow SP Input Max** This is the full range value in L/min for the Flow Setpoint analogue input (ANIN02). It corresponds to the maximum input value of 10V.
1946	**Flow SP Input Min** This is the minimum value in L/min for the Flow Setpoint analogue input (ANIN02). It corresponds to the minimum input value of 0V.
1947	**Flow Setpoint Max** This is the maximum Flow Setpoint that can be set using the GKP, terminals or fieldbus.
1948	**Flow Setpoint Min** This is the minimum Flow Setpoint that can be set using the GKP, terminals or fieldbus.
1949	**Flow Local Setpoint** This is the Local Setpoint in L/min settable using the GKP. It is limited to be between **1947: Flow Setpoint Max** and **1948: Flow Setpoint Min,** converted to a percentage of the flow rate at **0140: Pump Speed Max** and then used to set the **0592: Local Reference** parameter.

PNO	Parameter Descriptions
1950	**Flow Comms Setpoint***
	This is the value of the remote terminal flow setpoint. It is clamped to be between **1947: Flow Setpoint Max** and **1948: Flow Setpoint Min**.
1951	**Flow Setpoint***
	This diagnostic is the value of the active flow setpoint. This will be the same as one of the following: **1953: Flow Remote Setpoint** when in remote (terminal) control mode **1950: Flow Comms Setpoint** when in comms control mode **1949: Flow Local Setpoint** when in local control mode
1952	**Flow Feedback***
	This diagnostic is the value of the flow feedback in L/min. It is ANIN1 scaled and offset by **1943: Flow FB Input Max** and **1944: Flow FB Input Min**.
1953	**Flow Remote Setpoint***
	This diagnostic is the value of the remote terminal flow setpoint. It is ANIN2 scaled and offset by **1945: Flow SP Input Max** and **1946: Flow SP Input Min**, then clamped to be between **1947: Flow Setpoint Max** and **1948: Flow Setpoint Min**.
1954	**Pump Demand***
	This diagnostic is the requested speed of the pump as a percentage of **1940: Pump Speed Max**. It is the same as **0500: Ramp Speed Output**.
1955	**Actual load***
	This diagnostic is the estimated load as a percentage of the maximum load. It is the same as the **0399: Actual Torque** parameter which is the calculated torque based on the IQ current.

Functional Description

The maximum pump speed is set in RPM using the **1940: Pump Speed Max** parameter. This corresponds to 100% speed demand. A minimum speed may be set using the **1940: Pump Speed Min** parameter, also in RPM.

The calculation from flow the pump speed is set by the **0142: Pump Displacement** parameter.

The analog input used for the flow setpoint is scaled using the **1945: Flow SP Input Max** and **1946: Flow SP Input Min** parameters. These define the range and offset in L/min. Similarly, the analog input used for the flow feedback is scaled using the **1947: Flow FB Input Max** and **1948: Flow FB Input Min** parameters.

If not in flow control, the setpoint from either the GKP (1949: Flow Local Setpoint) or the communications (1950: Flow Comms Setpoint) may be used instead of the setpoint from the terminals.

PID

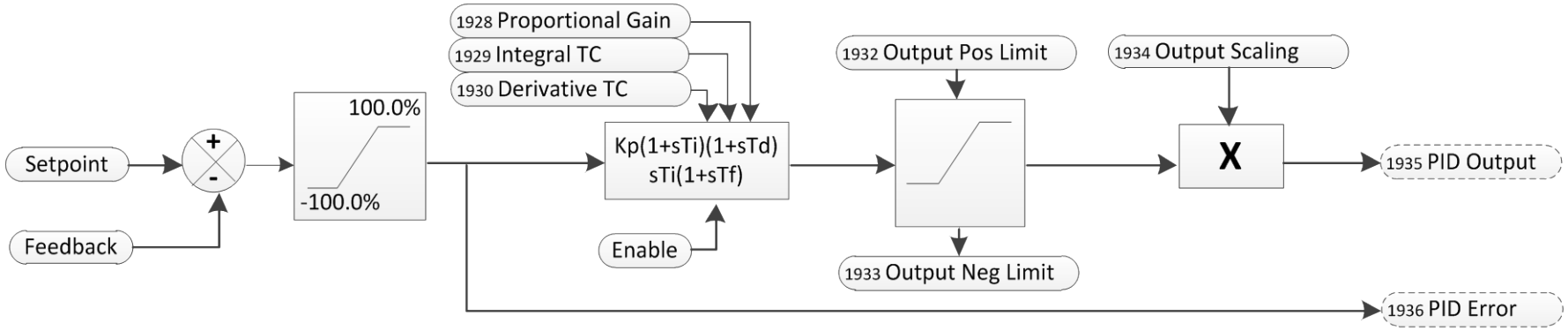
Setup::Application::PID
Monitor::Application::PID*

This function allows the AC30V to be used in applications requiring a trim to the reference, depending on feedback from an external measurement device. Typically this will be used for process control, i.e. pressure or flow.

PNO	Parameter Descriptions
	Setpoint This is connected to an Analog Input through the application.
	Feedback This is connected to an Analog Input through the application.
	Enable This is set TRUE by the application when flow control is required (AUTO mode). It globally resets the PID output and integral term when FALSE. **Enable** must be TRUE for the PID to operate.
1928	**PID Proportional Gain** This is the true proportional gain of the PID controller. When set to zero the PID Output is zero.
1929	**PID Integral TC** The integral time constant of the PID controller.
1930	**PID Derivative TC** The derivative time constant of the PID controller.

PNO	Parameter Descriptions
1931	**PID Output Filter TC** In order to help attenuate high frequency noise on the PID output, a first order output filter has been provided. This parameter determines the output filter time constant.
1932	**PID Output Pos Limit** The maximum positive excursion (limit) of the PID output.
1933	**PID Output Neg Limit** The maximum negative excursion (limit) of the PID output.
1934	**PID Output Scaling** The overall scaling factor which is applied after the positive and negative limit clamps
1935	**PID Output*** PID output monitor
1936	**PID Error*** PID error monitor. This is Setpoint – Feedback.

Functional Description



Abnormal Load Detect

Setup::Application::Abnormal Load Detect
Monitor::Application::Abnormal Load Detect*

When used in the Pump Control Application this feature is used to detect high load low load indicating blockage and low load indicating leakage.

PNO	Parameter Descriptions
1968	**Enable Load Monitor** Set TRUE to enable this feature.
1969	**Startup Delay** This sets the duration from when the motor is started until the load monitoring is started. This allows for inaccurate speed/load characterisation and load estimation during start-up period.
1970	**Fault Delay** This sets the duration from when the load monitor detects a LOAD FAULT until the sequencers stops the motor. This allows for inaccurate speed/load characterisation and load estimation during start-up period.
1971	**High Fault Level** This specifies the deviation of the actual load above the expected load which will cause a LOAD HIGH FAULT to be reported.
1972	**High Warning Level** This specifies the deviation of the actual load above the expected load which will cause a LOAD HIGH WARNING to be reported.
1973	**Low Warning Level** This specifies the deviation of the actual load below the expected load which will cause a LOAD LOW WARNING to be reported.
1974	**Low Fault Level** This specifies the deviation of the actual load below the expected load which will cause a LOAD LOW FAULT to be reported.
1976 1977 1978 1979 1980 1981 1982 1983 1984 1985	**Speed 1** **Speed 2** **Speed 3** **Speed 4** **Speed 5** **Speed 6** **Speed 7** **Speed 8** **Speed 9** **Speed 10** These 10 parameters specify together with the 10 Load parameters below are used to characterise the expected load ‘curve’ for the actual Speed.

PNO	Parameter Descriptions
1987	**Load 1**
1988	**Load 2**
1989	**Load 3**
1990	**Load 4**
1991	**Load 5**
1992	**Load 6**
1993	**Load 7**
1994	**Load 8**
1995	**Load 9**
1997	**Load 10**
	See above Speed parameters.
1997	**Load Monitor State***
	This diagnostic reports whether the monitor is monitoring and, if so, if the Load is as expected. This is an enumerated value:
	0 MONITORING DISABLED — Either **Enable Load Monitor** is FALSE or **Speed 1** = 0.0%.
	1 MONITORING STOPPED — Motor not running, so not monitoring.
	2 MONITORING STARTING — Motor started less than **Startup Delay** ago, so not monitoring yet.
	3 LOAD NORMAL — The actual Load is within the expected range, so anomaly detected.
	4 LOAD HIGH WARNING — The actual Load is above the **High Warning Level** but not higher than the **High Fault Level**.
	5 LOAD LOW WARNING — The actual Load is below the **Low Warning Level** but not lower than the **Low Fault Level**.
	6 LOAD HIGH FAULT — The actual Load is above the **High Fault Level.**
	7 LOAD LOW FAULT — The actual Load is below the **Low Fault Level.**
1998	**Expected Load***
	This diagnostic is the calculated Load expected for the current Speed. This is determined from the load ‘curve’ specified by the **Speed n** and **Load n** parameters and is useful for checking that in the case of incorrect warning or fault reporting.
1999	**Load Error***
	This diagnostic is difference between **Actual Load** and **Expected Load**.

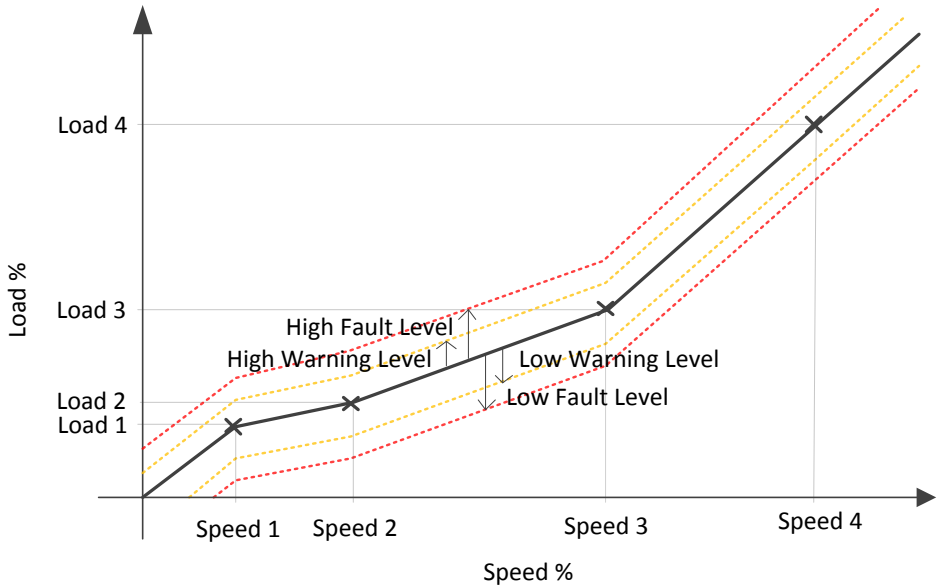
Functional Description

An estimate of the expected Load for any given Speed is specified using the **Speed n** and **Load n** parameters. Each pair provide a point on the expected Load line.

The Speed parameters must have increasing values. I.e. **Speed 1** < **Speed 2** < **Speed 3** < **Speed 4** < **Speed 5** < **Speed 6** < **Speed 7** < **Speed 8** < **Speed 9** < **Speed 10**.

If not all points are required, a Speed may be set to zero to terminate the sequence. If the actual speed is greater than the last specified point, the line is extrapolated from the previous 2 points.

Speed 1 must be non-zero, otherwise the abnormal load detection feature is disabled.



Offset from the expected Load line, 4 additional lines are calculated. These are the Warning and Fault detection thresholds. The deviation from normal behavior is determined by the **High Fault Level** , **High Warning Level**, **Low Warning Level** and **Low Fault Level** parameters.

When running, the **Load Monitor State** diagnostic will show if the actual Load is in the NORMAL, WARNING or FAULT regions of the graph. Note – for this to report correctly, the **High Fault Level** must be more positive than the **High Warning Level** and the **Low Fault Level** must be more negative than the **Low Warning Level**.

If the actual Load remains in a FAULT region for longer than the duration specified by **Fault Delay**, the Drive will stop running.

The **Start Delay** may be used to prevent incorrect warning or fault reports soon after the Run command is issued.

The **Load Monitor State** diagnostic is reset when the Run command is removed.

Sequencing

Setup::Application::Sequencing
Monitor::Application::Sequencing

The Pump Control Application introduces these additional sequencing parameters.

PNO	Parameter Descriptions
1937	**Disable Coast Stop** When TRUE, the default for this parameter, the COAST STOP input is ignored.
1960	**Power Up Start** When TRUE the Drive will immediately run on power up if the AUTO RUN or MANUAL RUN digital input is TRUE. If this parameter is FALSE (the default) a FALSE to TRUE transition of the RUN input is required.
1956	**Auto Manual State*** This diagnostic reports whether the drive is AUTO or MANUAL mode and the running state of the Pump. 0 MANUAL DISABLED 1 MANUAL STOPPED 2 MANUAL RUNNING — Pump running in speed control 3 MANUAL STOPPING 4 AUTO DISABLED 5 AUTO STOPPED 6 AUTO RUNNING — Pump running in flow control 7 AUTO STOPPING
1957	**Feedback Input Break*** This diagnostic is TRUE when the flow feedback analogue input is not working. Flow control will not operate.

Functional Description

Disable Coast Stop:
This feature disables the use of the COAST STOP input.

Caution The Drive will not stop when the coast stop input is disconnected.

Power Up Start:
This feature removes the requirement of a transition from FALSE to TRUE on the run command. This allows an immediate start of the motor when power is applied to the Drive.

Caution The Drive may run without warning.

PARAMETER TABLE

PNO	Name	Path(s)	Type	Default	Range	Units	WQ	Modbus
1928	PID Proportional Gain	Setup::Application::PID	REAL	1.0	0.0 to 100.0		ALWAYS	04383
1929	PID Integral TC	Setup::Application::PID	TIME	1.00	0.01 to 100.00	s	ALWAYS	04385
1930	PID Derivative TC	Setup::Application::PID	TIME	0.000	0.000 to 10.000	s	ALWAYS	04387
1931	PID Output Filter TC	Setup::Application::PID	TIME	0.1	0.000 to 10.000	s	ALWAYS	04389
1932	PID Output Pos Limit	Setup::Application::PID	REAL	100.00	0.00 to 105.00	%	ALWAYS	04391
1933	PID Output Neg Limit	Setup::Application::PID	REAL	-100.00	-105.00 to 0.00	%	ALWAYS	04393
1934	PID Output Scaling	Setup::Application::PID	REAL	1.00	-10.00 to 10.00		ALWAYS	04395
1935	PID Output	Monitor::Application::PID	REAL	0.00		%	NEVER	04397
1936	PID Error	Monitor::Application::PID	REAL	0.00		%	NEVER	04399
1937	Disable Coast Stop	Setup::Application::Sequencing	BOOL	TRUE			STOPPED	04401
1940	Pump Speed Max	Setup::Application::Pump and Flow	REAL	100.0	1.0 to 10000.0	L/min	STOPPED	04407
1941	Pump Speed Min	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	STOPPED	04409
1942	Pump Displacement	Setup::Application::Pump and Flow	REAL	1.00	0.01 to 1000.00	L/rev	STOPPED	04411
1943	Flow FB Input Max	Setup::Application::Pump and Flow	REAL	100.0	1.0 to 10000.0	L/min	STOPPED	04413
1944	Flow FB Input Min	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	STOPPED	04415
1945	Flow SP Input Max	Setup::Application::Pump and Flow	REAL	100.0	1.0 to 10000.0	L/min	STOPPED	04417
1946	Flow SP Input Min	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	STOPPED	04419
1947	Flow Setpoint Max	Setup::Application::Pump and Flow	REAL	100.0	1.0 to 10000.0	L/min	STOPPED	04421
1948	Flow Setpoint Min	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	STOPPED	04423
1949	Flow Local Setpoint	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	%	ALWAYS	04425
1950	Flow Comms Setpoint	Setup::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	%	ALWAYS	04427
1951	Flow Setpoint	Monitor::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	NEVER	04429
1952	Flow Feedback	Monitor::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	NEVER	04431
1953	Flow Remote Setpoint	Monitor::Application::Pump and Flow	REAL	0.0	0.0 to 10000.0	L/min	NEVER	04433
1954	Pump Demand	Monitor::Application::Pump and Flow	REAL	0.0	0.0 to 100.0	%	NEVER	04435
1955	Actual Load	Monitor::Application::Pump and Flow	REAL	0.0	0.0 to 100.0	%	NEVER	04437

PNO	Name	Path(s)	Type	Default	Range	Units	WQ	Modbus
1956	Auto Manual State	Monitor::Application::Sequencing	USINT (enum)	0	0: MANUAL DISABLED 1: MANUAL STOPPED 2: MANUAL RUNNING 3: MANUAL STOPPING 4: AUTO DISABLED 5: AUTO STOPPED 6: AUTO RUNNING 7: AUTO STOPPING		NEVER	04439
1957	Feedback Input Break	Monitor::Application::Sequencing	BOOL	FALSE			NEVER	04441
1960	Power Up Start	Setup::Application::Sequencing	BOOL	FALSE			ALWAYS	04447
1968	Enable Load Monitor	Setup::Application::Abnormal Load Detect	BOOL	0			ALWAYS	04463
1969	Startup Delay	Setup::Application::Abnormal Load Detect	TIME	10		s	ALWAYS	04465
1970	Fault Delay	Setup::Application::Abnormal Load Detect	TIME	1		s	ALWAYS	04467
1971	High Fault Level	Setup::Application::Abnormal Load Detect	REAL	100.0	0.0 to 100.0	%	ALWAYS	04469
1972	High Warning Level	Setup::Application::Abnormal Load Detect	REAL	100.0	0.0 to 100.0	%	ALWAYS	04471
1973	Low Warning Level	Setup::Application::Abnormal Load Detect	REAL	-100.0	-100.0 to 0.0	%	ALWAYS	04473
1974	Low Fault Level	Setup::Application::Abnormal Load Detect	REAL	-100.0	-100.0 to 0.0	%	ALWAYS	04475
1976	Speed 1	Setup::Application::Abnormal Load Detect	REAL	0.0	0.0 to 100.0	%	ALWAYS	04479
1977	Speed 2							04481
1978	Speed 3							04483
1979	Speed 4							04485
1980	Speed 5							04487
1981	Speed 6							04489
1982	Speed 7							04491
1983	Speed 8							04493
1984	Speed 9							04495
1985	Speed 10							04497
1987	Load 1	Setup::Application::Abnormal Load Detect	REAL	0.0	0.0 to 100.0	%	ALWAYS	04501
1988	Load 2							04503
1989	Load 3							04505
1990	Load 4							04507

PNO	Name	Path(s)	Type	Default	Range	Units	WQ	Modbus
1991	Load 5							04509
1992	Load 6							04511
1993	Load 7							04513
1994	Load 8							04515
1995	Load 9							04517
1996	Load 10							04519
1997	Load Monitoring State	Monitor::Application::Abnormal Load Detect	USINT (enum)	0	0: MONITORING DISABLED 1: MONITORING STOPPED 2: MONITORING STARTING 3: LOAD NORMAL 4: LOAD HIGH WARNING 5: LOAD LOW WARNING 6: LOAD HIGH FAULT 7: LOAD LOW FAULT		ALWAYS	04521
1998	Expected Load	Monitor::Application::Abnormal Load Detect	REAL	0.0	0.0 to 100.0	%	NEVER	04523
1999	Load Error	Monitor::Application::Abnormal Load Detect	REAL	0.0	-400.0 to 400.0	%	NEVER	04525

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