TULSA Water and Sewer Department

SCADA System Improvements

Analog Flow Add-On Instruction

FINAL

PRESENTED TO

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Revision History

After the Add-On Instruction has been modified or updated, this document should be revised to reflect the changes. The version is broken into two parts: major (**X**.0) and minor (1.**X**). A major version is reserved for adding or removing sections of this document. A minor version is reserved for modifications to existing sections.

Version	Date	Description
1.0	July 9, 2021	AOI created in Studio 5000 Version 21.11, Draft submitted to client
1.0	April 4, 2022	Final submitted to client.

1   INTRODUCTION

The Analog Flow Add-On Instruction (AOI) reads raw data from a field flow meter and scales it to engineering units. The AOI includes four levels of alarms – high-high, high, low, low-low – with associated trip and reset setpoints that are configurable from the HMI. It also includes an out of range alarm to indicate if the value is outside of the configured scale. Value clamping is available and can be enabled to prevent the scaled value from going outside the configured scale. Statistics included in the AOI are: minimum, maximum, and average value for the current and previous day; as well as hourly, daily, monthly, yearly, and cumulative flow totals. The analog flow can be taken out of service to disable its alarms and statistics.

Table 1-1 Embedded AOIs

Embedded AOIs
Linear Scale
Analog Trip Reset
Flow Totalizer
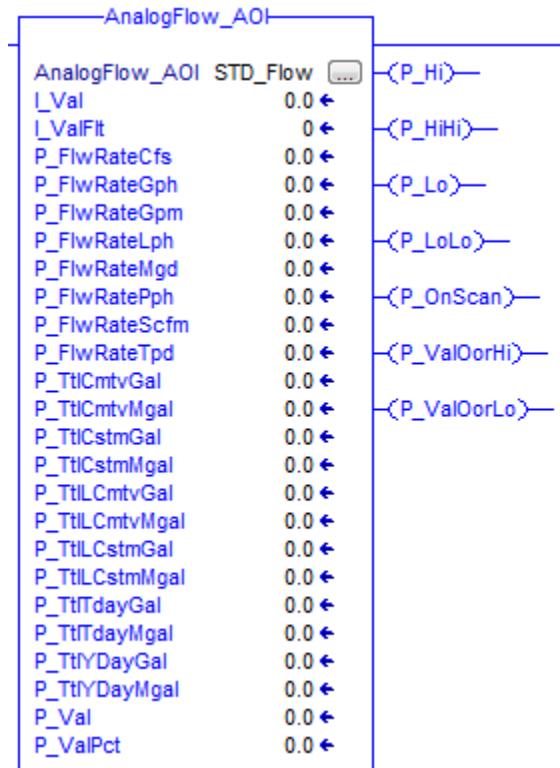
Figure 1-1 Analog Flow AOI as it appears in ladder logic

2   TEMPLATE

Template logic can be found in the Unscheduled Programs/Phases task folder of the Tulsa ControlLogix Standard PLC file. Because the template task is unscheduled, the routines within it do not execute during runtime. The intention of the template routine is to provide a standard logic structure for the AOIs that can be copied into the executable tasks of the MainProgram.

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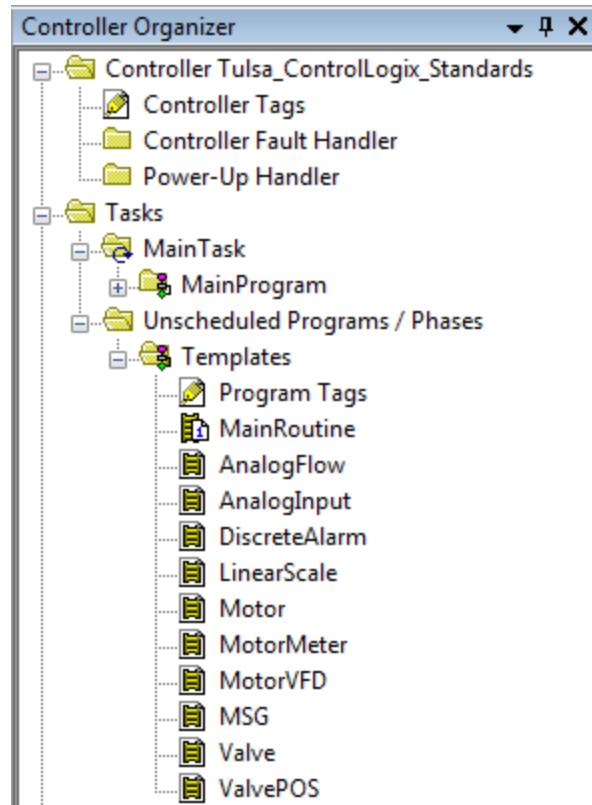
Figure 2-1 Unscheduled Standard Logic Templates

The analog flow template routine displays the standard logic for using the Analog Flow AOI. In the first rung, minute, hour, day, month, and year resets from the PLC AOI are used to reset the flow statistics. The following two rungs use data from the raw analog input channel to indicate the value fault and raw value inputs.
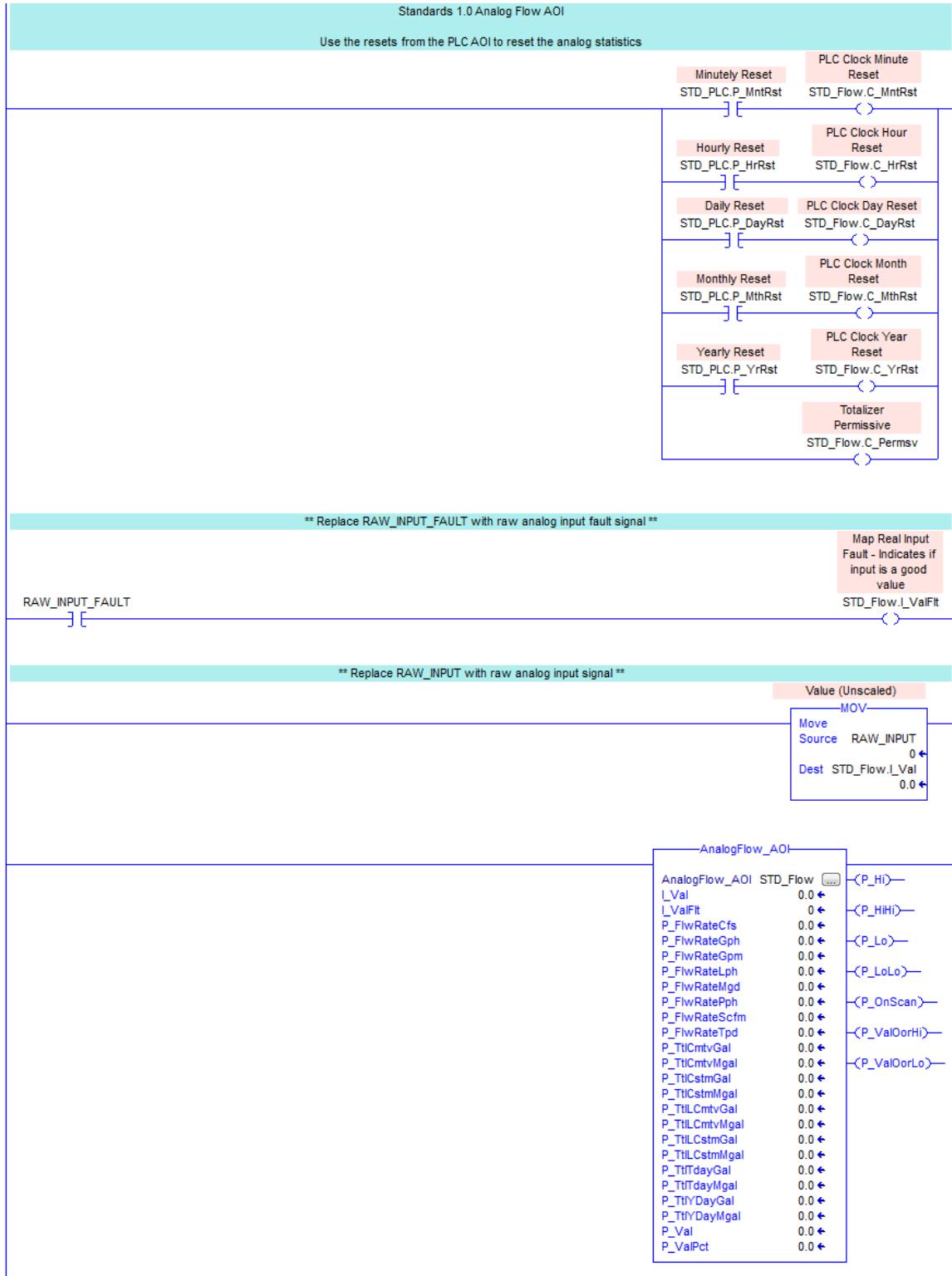
Figure 2-2 Standard Template Logic for the Analog Flow AOI

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3   FEATURES

3.1   Configuration Tags

Configuration tags are inputs to the AOI that are set by the engineer during programming and equipment start-up. A "C_" prefix is used to indicate that the tag modifies the configuration of an equipment or instrument.

3.1.1   Signal Conditioning

Table 3-1 Configuration Signal Conditioning Tags

Parameter	Data Type	Description	Default Value
C_HiEngUnits	REAL	The maximum value of the scaled analog signal.	100
C_HiLimClmp	REAL	Used instead of the scaled value, if the scaled value is higher and C_HiLimClmpEn is true.	0
C_HiLimClmpEn	BOOL	Enables clamping for high scaled values.	False
C_HiRaw	REAL	The maximum value of the raw analog input signal.	20
C_InEngUnits	INT	Flow rate engineering units. 1 = GPM, 2 = GPH, 4 = MGD, 8 = CFS, 16 = SCFM, 32 = tons/day, 64 = liters/hr, 128 = lbs/hr	1
C_InvIn	BOOL	When true, the value is inverted when scaling, i.e. the max. raw value would correspond to the min. engineering value.	False
C_LoEngUnits	REAL	The minimum value of the scaled analog signal.	0
C_LoLimClmp	REAL	Used instead of the scaled value, if the scaled value is lower and C_LoLimClmpEn is true.	0
C_LoLimClmpEn	BOOL	Enables clamping for low scaled values.	False
C_LoRaw	REAL	The minimum value of the raw analog input signal.	4
C_ValClmpEn	BOOL	When true, the scaled value is clamped between C_LoEngUnits and C_HiEngUnits.	False

3.1.2   Alarms and Permissives

Table 3-2 Configuration Alarm and Permissive Tags

Parameter	Data Type	Description	Default Value
C_HiHiPermsv	BOOL	External signal mapped into the AOI to allow the high-high alarm to become active.	False
C_HiHiPri	DINT	High-high alarm priority.	200
C_HiPermsv	BOOL	External signal mapped into the AOI to allow the high alarm to become active.	False
C_HiPri	DINT	High alarm priority.	300
C_LoLoPermsv	BOOL	External signal mapped into the AOI to allow the low-low alarm to become active.	False
C_LoLoPri	DINT	Low-low alarm priority.	200
C_LoPermsv	BOOL	External signal mapped into the AOI to allow the low alarm to become active.	False
C_LoPri	DINT	Low alarm priority.	300

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C_Permsv	BOOL	Flow totalization permissive.	False
C_ValFltLgcEn	BOOL	Enables the value fault alarm.	False
C_ValFltPermsv	BOOL	External signal mapped into the AOI to all the value fault alarm to become active.	False
C_ValFltPri	DINT	Value fault alarm priority.	400
C_ValOorPct	REAL	Setpoint used to calculate the value out of range high and low setpoints when monitoring the raw input signal.	2%

3.1.3 Statistics

Table 3-3 Configuration Time and Date Tags

Parameter	Data Type	Description	Default Value
C_CstmPerRst	BOOL	Reset flow totalizing for custom period.	False
C_CstmPerStrt	BOOL	Start flow totalizing for custom period.	False
C_DayRst	BOOL	Day trigger to reset the daily statistics, externally mapped from the PLC clock.	False
C_HrRst	BOOL	Hour trigger to reset the hourly statistics, externally mapped from the PLC clock.	False
C_MntRst	BOOL	Minute trigger to reset the minutely statistics, externally mapped from the PLC clock.	False
C_MthRst	BOOL	Month trigger to reset the monthly statistics, externally mapped from the PLC clock.	False
C_YrRst	BOOL	Year trigger to reset the yearly statistics, externally mapped from the PLC clock.	False

3.2 Input Tags

Input tags are inputs to the AOI that are set by the I/O and indicate equipment status. The "I_" prefix is used to indicated that the tag is displaying an equipment or instrument status.

Table 3-4 Input Tags

Parameter	Data Type	Description
I_Val	REAL	Raw input value mapped into the AOI for signal conditioning and alarming.
I_ValFlt	BOOL	External signal mapped into the AOI for determining if input value is good.

3.3 Output Tags

Output tags are outputs from the AOI that are used to control equipment. The "O_" prefix is used to indicate that the tag controls a real-world output within the PLC. The Analog Flow AOI does not contain any output tags.

3.4 HMI Tags

HMI tags are inputs to the AOI that are set by the operator. The "H_" prefix is used to indicate that the tag modifies a PLC register from the operator interface.

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3.4.1 Functionality

Table 3-5 HMI Functionality Tags

Parameter	Data Type	Description	Default Value
H_Oos	BOOL	When true, the analog value is out of service. Disables all alarms when active.	False
H_Rst	BOOL	Reset all totalized values.	False

3.4.2 Alarms

Table 3-6 HMI Alarm Tags

Parameter	Data Type	Description	Default Value
H_HiEn	BOOL	Enables the high alarm.	False
H_HiHiEn	BOOL	Enables the high-high alarm.	False
H_HiHiRst	REAL	High-high alarm reset setpoint. High-high alarm clears when the value drops below this setpoint.	0
H_HiHiTrp	REAL	High-high alarm trip setpoint. High-high alarm triggers when the value is above this setpoint.	0
H_HiRst	REAL	High alarm reset setpoint. High alarm clears when the value drops below this setpoint.	0
H_HiTrp	REAL	High alarm trip setpoint. High alarm triggers when the value is above this setpoint.	0
H_LoEn	BOOL	Enables the low alarm.	False
H_LoLoEn	BOOL	Enables the low-low alarm.	False
H_LoLoRst	REAL	Low-low alarm reset setpoint. Low-low alarm clears when the value goes above this setpoint.	0
H_LoLoTrp	REAL	Low-low alarm trip setpoint. Low-lo alarm triggers when the value drops below this setpoint.	0
H_LoRst	REAL	Low alarm reset setpoint. Low alarm clears when the value goes above this setpoint.	0
H_LoTrp	REAL	Low alarm trip setpoint. Low alarm triggers when the value drops below this setpoint.	0
H_ValFltEn	BOOL	Enables the value fault alarm.	False

3.4.3 Timer Settings

Table 3-7 HMI Timer Setting Tags

Parameter	Data Type	Description	Default Value
H_AlmDlyTmSec	REAL	Delay time common to the high-high, high, low, and low-low alarms.	5
H_ValFltDlyTm	REAL	Delay time for the value fault alarm.	5

3.5 PLC Logic Tags

PLC Logic tags are attributes internal to the AOI. The "P_" prefix is used to indicate that the tag is modified or calculated within the PLC.

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3.5.1 Status Indication

Table 3-8 PLC Logic Status Indication Tags

Parameter	Data Type	Description	Historian
P_FlwRateCfs	REAL	Flow rate displayed in cubic feet per second.	No
P_FlwRateGph	REAL	Flow rate displayed in gallons per hour.	No
P_FlwRateGpm	REAL	Flow rate displayed in gallons per minute.	No
P_FlwRateLph	REAL	Flow rate displayed in liters per hour.	No
P_FlwRateMgd	REAL	Flow rate displayed in million gallons per hour.	No
P_FlwRatePph	REAL	Flow rate displayed in pounds per hour.	No
P_FlwRateScfm	REAL	Flow rate displayed in standard cubic feet per minute.	No
P_FlwRateTpd	REAL	Flow rate displayed in tons per day.	No
P_InAlm	BOOL	Indicates that an alarm is active.	No
P_MaxAlmPri	DINT	Displays the highest priority of the active alarms. 100=critical, 200=high, 300=medium, 400=low.	No
P_Val	REAL	Scaled value in engineering units.	Yes
P_ValPct	REAL	Scaled value expressed as 0-100% of the engineering units scale.	No

3.5.2 Alarms

Table 3-9 PLC Logic Alarm Tags

Parameter	Data Type	Description	Alarm
P_Hi	BOOL	High alarm activated if the value is higher than H_HiTrp for longer than H_AlmDlyTmSec. Alarm latches until the value is lower than H_HiRst for longer than H_AlmDlyTmSec.	Yes
P_HiHi	BOOL	High-high alarm activated if the value is higher than H_HiHiTrp for longer than H_AlmDlyTmSec. Alarm latches until the value is lower than H_HiHiRst for longer than H_AlmDlyTmSec.	Yes
P_Lo	BOOL	Low alarm activated if the value is lower than H_LoTrp for longer than H_AlmDlyTmSec. Alarm latches until the value is higher than H_LoRst for longer than H_AlmDlyTmSec.	Yes
P_LoLo	BOOL	Low-low alarm activated if the value is lower than H_LoLoTrp for longer than H_AlmDlyTmSec. Alarm latches until the value is higher than H_LoLoRst for longer than H_AlmDlyTmSec.	Yes
P_ValFlt	BOOL	Value fault alarm activated if external I_ValFlt is true or if either out of range alarms becomes active.	Yes
P_ValFltLgc	BOOL	Value fault condition that disables alarm logic.	No
P_ValOorHi	BOOL	Value out of range high alarm activated if the raw value exceeds C_HiRaw by more than C_ValOorPct.	No

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Parameter			
P_ValOorHiSp	REAL	Value out of range high setpoint, calculated using C_ValOorPct and C_HiRaw.	No
P_ValOorLo	BOOL	Value out of range low alarm activated if the raw value is less than C_LoRaw by more than C_ValOorPct.	No
P_ValOorLoSp	REAL	Value out of range low setpoint, calculated using C_ValOorPct and C_LoRaw.	No

3.5.3   Statistics

Table 3-10 PLC Logic Statistics Tags

Parameter	Data Type	Description
P_AvgMnt	REAL	Current minute average value of the analog signal.
P_AvgTday	REAL	Current daily average value of the analog signal.
P_AvgYday	REAL	Previous daily average value of the analog signal.
P_MaxTday	REAL	Current daily maximum value of the analog signal.
P_MaxYday	REAL	Previous daily maximum value of the analog signal.
P_MinTday	REAL	Current daily minimum value of the analog signal.
P_MinYday	REAL	Previous daily minimum value of the analog signal.
P_TtlCmtvGal	REAL	Total cumulative gallons.
P_TtlCmtvKgal	REAL	Total cumulative K gallons.
P_TtlCmtvMgal	REAL	Total cumulative M gallons.
P_TtlCstmGal	REAL	Total custom period gallons.
P_TtlCstmKgal	REAL	Total custom period K gallons.
P_TtlCstmMgal	REAL	Total custom period M gallons.
P_TtlHrGal	REAL	Total hourly gallons.
P_TtlHrKgal	REAL	Total hourly K gallons.
P_TtlHrMgal	REAL	Total hourly M gallons.
P_TtlLCmtvGal	REAL	Total last cumulative gallons.
P_TtlLCmtvKgal	REAL	Total last cumulative K gallons.
P_TtlLCmtvMgal	REAL	Total last cumulative M gallons.
P_TtlLCstmGal	REAL	Total last custom gallons.
P_TtlLCstmKgal	REAL	Total last custom K gallons.
P_TtlLCstmMgal	REAL	Total last custom M gallons.
P_TtlLHrGal	REAL	Total last hour gallons.
P_TtlLHrKgal	REAL	Total last hour K gallons.
P_TtlLHrMgal	REAL	Total last hour M gallons.
P_TtlLMthGal	REAL	Total last month gallons.
P_TtlLMthKgal	REAL	Total last month K gallons.
P_TtlLMthMgal	REAL	Total last month M gallons.
P_TtlLYrGal	REAL	Total last year gallons.
P_TtlLYrKgal	REAL	Total last year K gallons.
P_TtlLYrMgal	REAL	Total last year M gallons.
P_TtlMthGal	REAL	Total monthly gallons.

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P_TtlMthKgal	REAL	Total monthly K gallons.
P_TtlMthMgal	REAL	Total monthly M gallons.
P_TtlTdayGal	REAL	Total daily gallons.
P_TtlTdayKgal	REAL	Total daily K gallons.
P_TtlTdayMgal	REAL	Total daily M gallons.
P_TtlYdayGal	REAL	Total last day gallons.
P_TtlYdayKgal	REAL	Total last day K gallons.
P_TtlYdayMgal	REAL	Total last day M gallons.
P_TtlYrGal	REAL	Total yearly gallons.
P_TtlYrKgal	REAL	Total yearly K gallons.
P_TtlYrMgal	REAL	Total yearly M gallons.

3.5.4   Additional Logic Tags

Table 3-11 PLC Logic Additional Tags

Parameter	Data Type	Description
P_OnScan	BOOL	Logic is on scan and valid. Signal is active if H_Oos is false and P_VallvldLgc is false. Must be active for high-high, high, low, and low-low alarms to become activated.

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