One Model - two S88.01 methods!

This is an export from a ControlDraw model that shows alternative ways of implementing S88 control.
The model contains two production units, one with physical and procedural control based on typical implementations by major process automation suppliers, the other with a much simpler structure that is equally capable but with much simpler 'chemists recipes'.

ControlDraw is versatile and handles either approach, and in fact in the model it does so by using Variants - one for the 'Typical' or EM Centric approach and one for the Simple or Unit Centric.

This PDF shows the Unit oriented version.

Table of Contents

Description for Diagram 1 - Process Cell

Process Description:

Process Inputs:

Feed material 1 is a liquid
Feed material 2 - contains ingredients

Process Outputs:

Batches of Stuff
This stuff may be one of several types depending on the recipe used.

The Process

The Production Unit can run several recipes and these are not all known. The chemist should be able to design any recipe that is built from the basic steps in any order
Addition of Feed 1
Addition of Feed 2
Agitation
Temperature control

An example of a simple recipe is

1. Add some Feed 1 to the Production Unit
2. Add some Feed 2
3. Start agitation at Speed1 and raise the temperature to Temp1
4. Over a period of Time1, Increase the agitation speed to Speed2 and the temperature to Temp2.
5. Over a period of Time1, reduce the agitation speed to Speed3 and the temperature to Temp3
6. Transfer the completed batch to the product vessel

During steps 3 to 4 if the temperature cannot be ramped fast enough then the time should be extended using a calculation (to be provided, ramp dwell to be used first)
At the end of this the material is ready and can wait.
Transfer the completed batch

More complex recipes are also possible, for example with a second stage of addition, or even more, or with more complex temperature profiles.

Diagram 1 - Process Cell

The P&ID 3/1

S88UT
Typical Unit, the way many suppliers do it
2/1

S88ST
Simple Unit
2/2

Process model Object Mapping 30

S88 Control Activity Model 31

Typical Recipe 10/1

Simpler Recipe 10/2

What is a Recipe Parameter 32

Phases are not complete in this model but are indicative

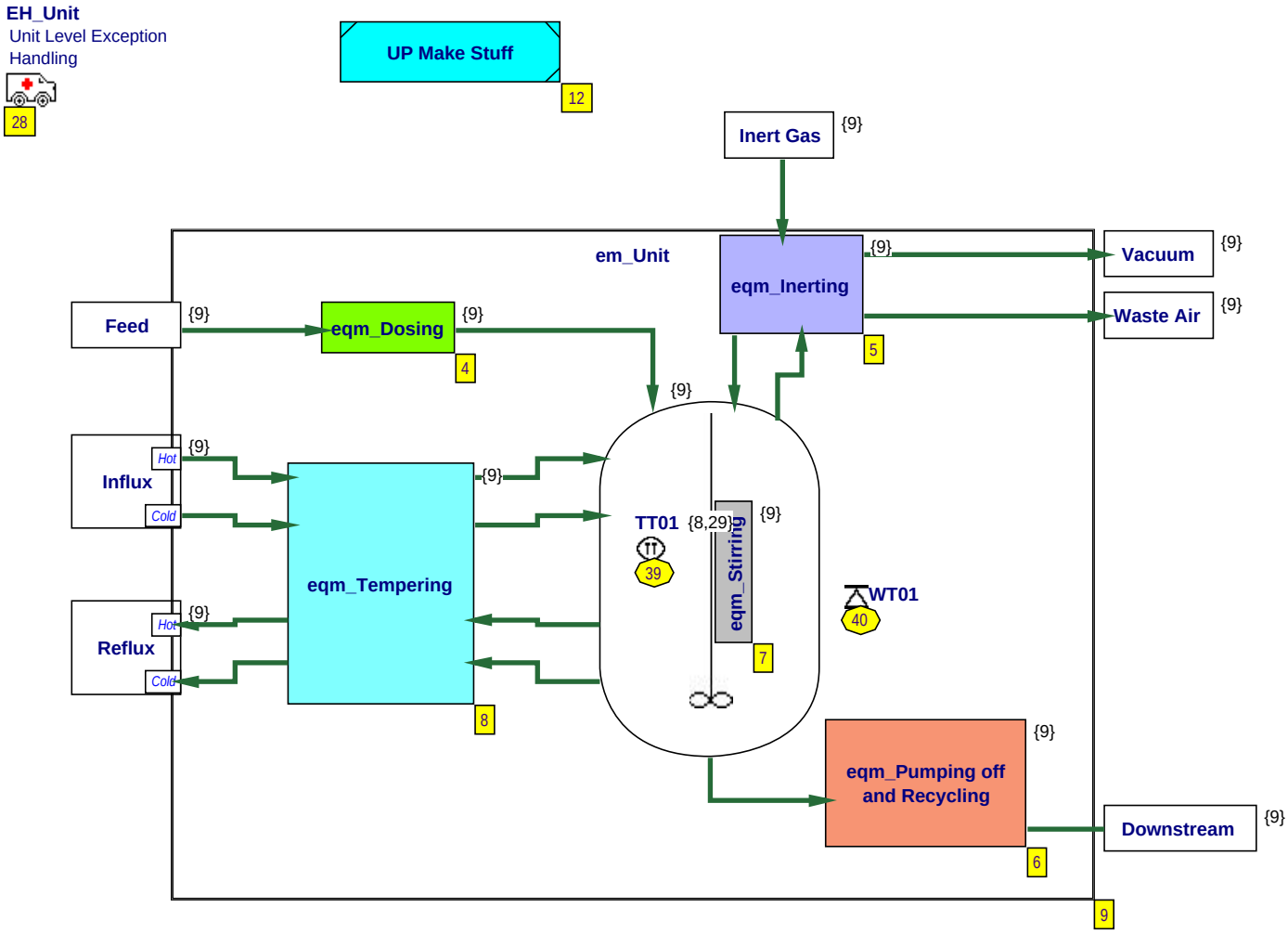
Note

The purpose of this model is to demonstrate alternative ways of implementing S88 control.
The model contains two production units, one with physical and procedural control based on typical implementations by major process automation suppliers, the other with a much simpler structure that is equally capable but with much simpler 'chemists recipes'.

IO Type	Count
AI	2
AO	10
DI	36
DO	30
SI	2
Total	80

This model includes levels down to the IO and generates an IO List

Diagram 2 - S88 Unit

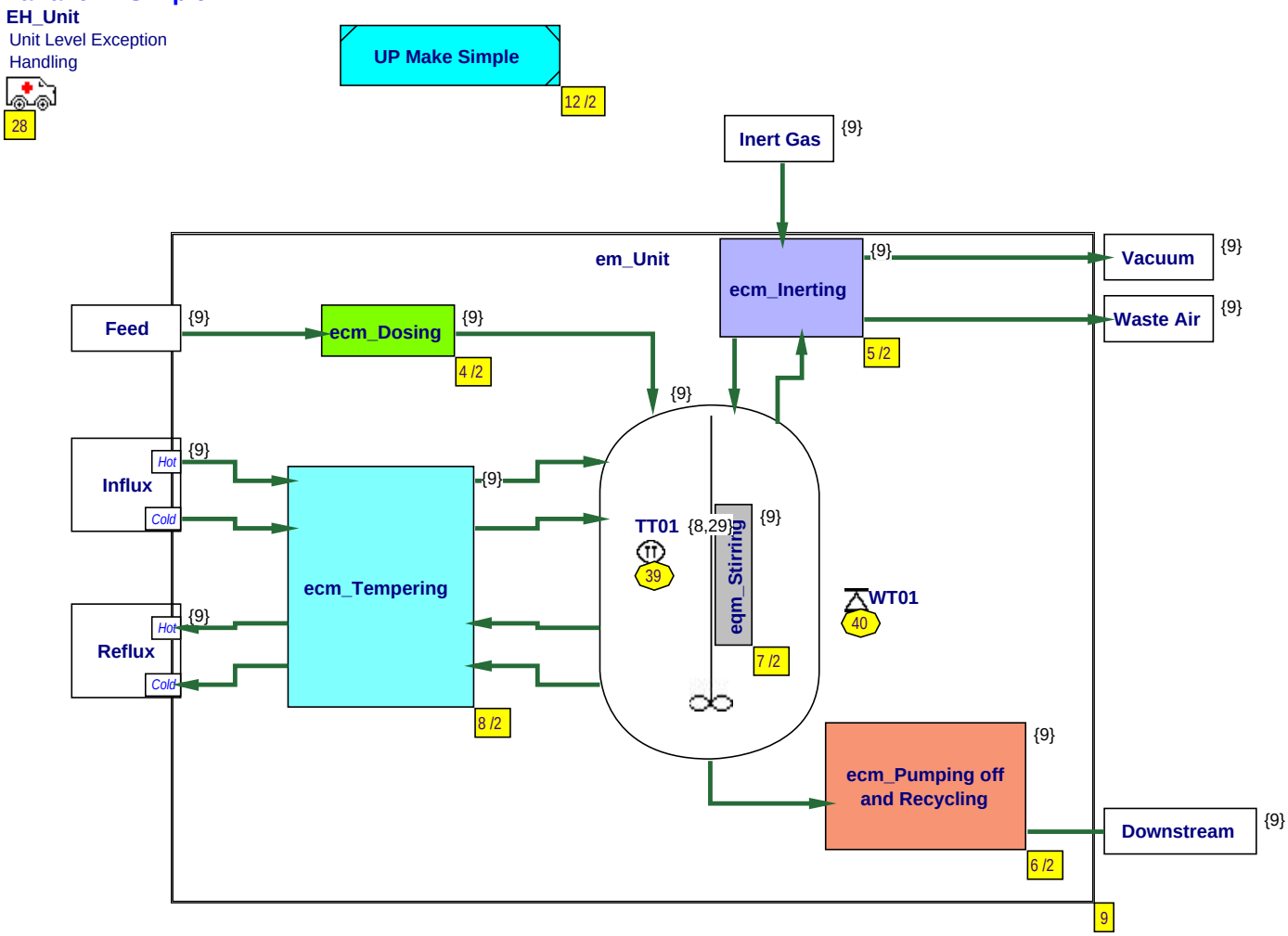


S88 Unit

	eqm_Dosing	eqm_Inerting	eqm_Pumping off and Recycling	eqm_Stirring	eqm_Tempering
Idle	Idle	Idle	Idle	Idle	Idle
Fast Dosing	Fast Dosing	Venting	Idle	Run	Idle
Slow Dosing	Slow Dosing	Venting	Idle	Idle	Run Profile
Inerting	Idle	Inerting	Recycling	Run	Run Profile
HeatUp	Idle	Inerting	Recycling	Run	Full Heat
Tempering	Idle	Inerting	Recycling	Run	Run Profile
Pumping	Idle	Venting	Pumping	Idle	Idle
CoolDown	Idle	Idle	Idle	Idle	Full Cool

Diagram 2 - S88 Unit

Variant 2 - Simple

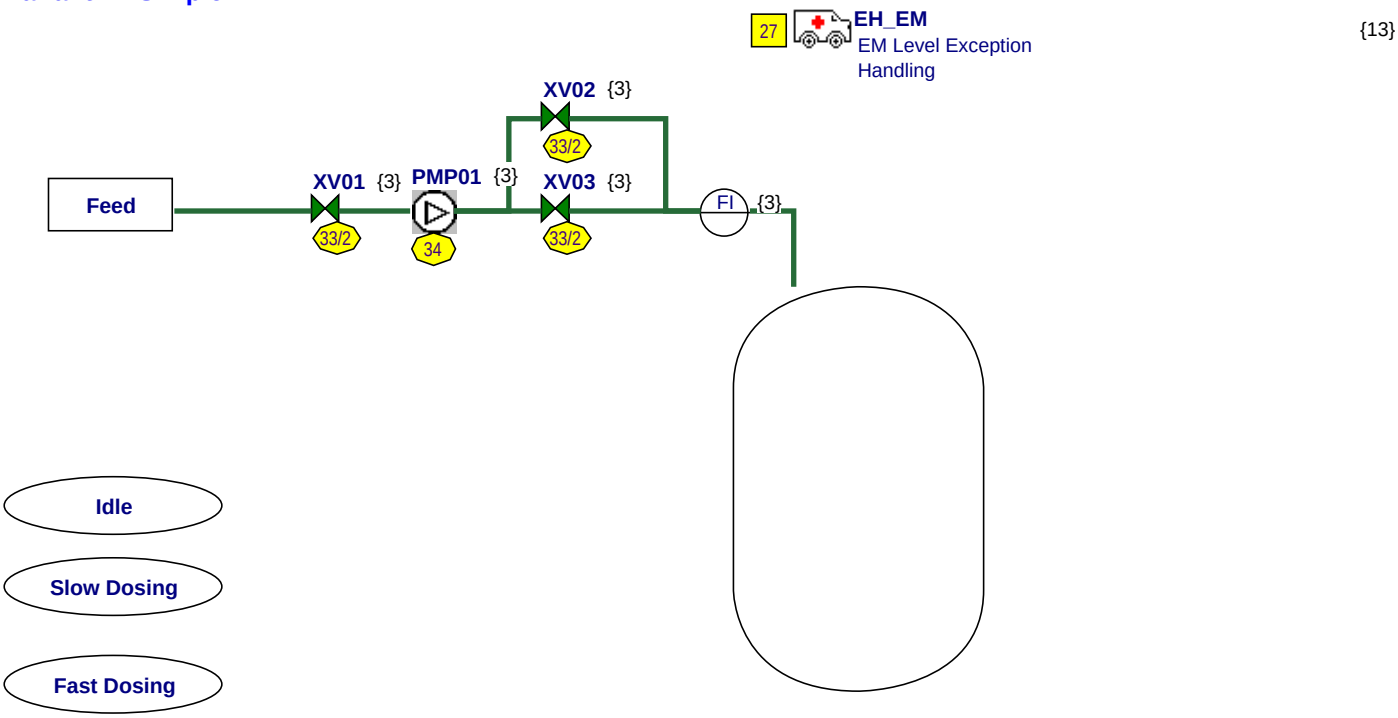


S88 Unit

	ecm_Dosing	ecm_Inerting	ecm_Pumping off and Recycling	eqm_Stirring	ecm_Tempering
Idle	Idle	Idle	Idle	Idle	Idle
Fast Dosing	Fast Dosing	Venting	Idle	Run	Idle
Slow Dosing	Slow Dosing	Venting	Idle	Idle	Run Profile
Inerting	Idle	Inerting	Recycling	Run	Run Profile
HeatUp	Idle	Inerting	Recycling	Run	Full Heat
Tempering	Idle	Inerting	Recycling	Run	Run Profile
Pumping	Idle	Venting	Pumping	Idle	Idle
CoolDown	Idle	Idle	Idle	Idle	Full Cool

Diagram 4 - em04 Dosing

Variant 2 - Simple



em_Dosing

	P01	XV01	XV02	XV03
Idle	Stop	Close	Close	Close
Slow Dosing	Run	Open	Open	Close
Fast Dosing	Run	Open	Open	Open

Diagram 5 - em05 Inerting

Variant 2 - Simple

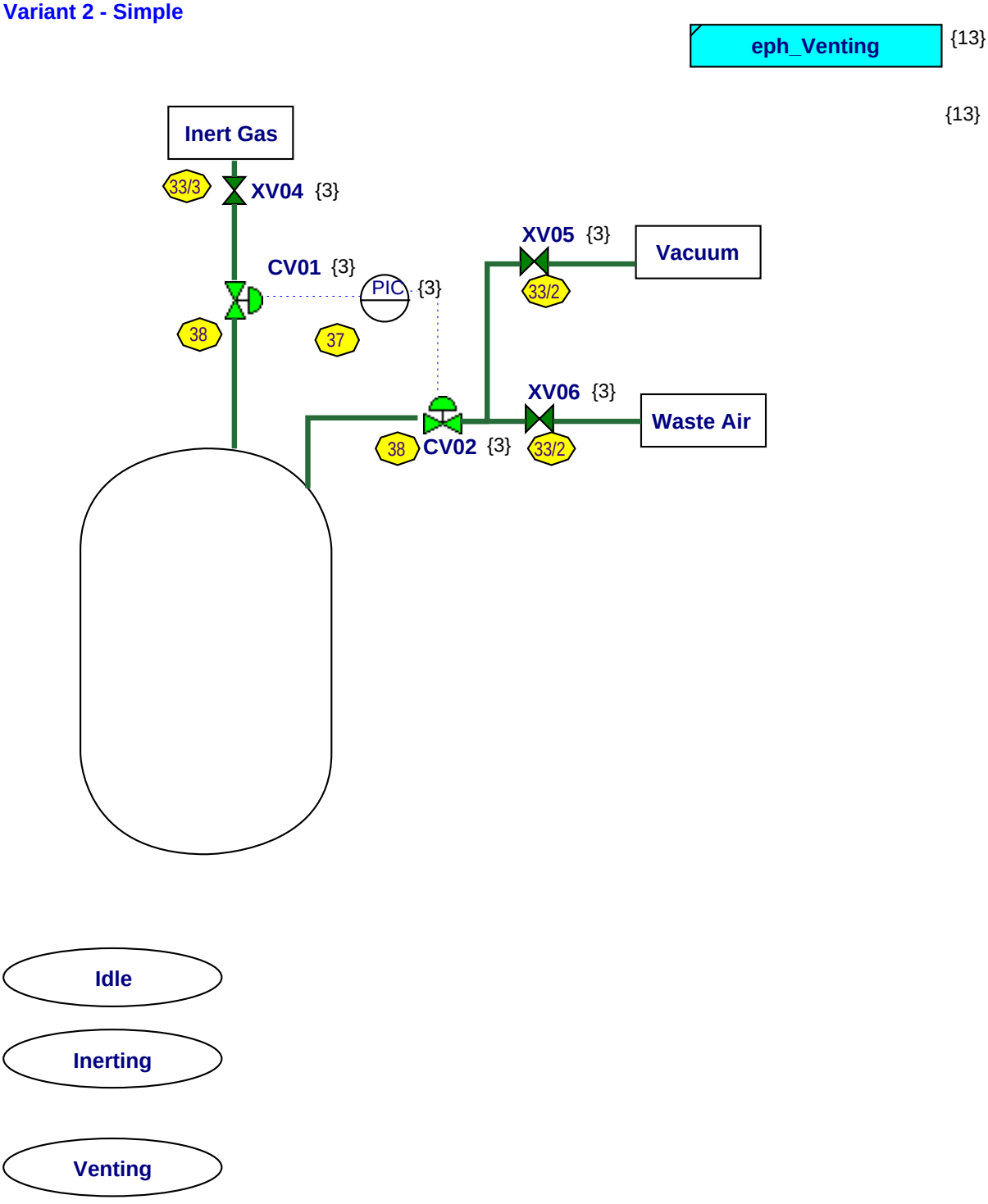
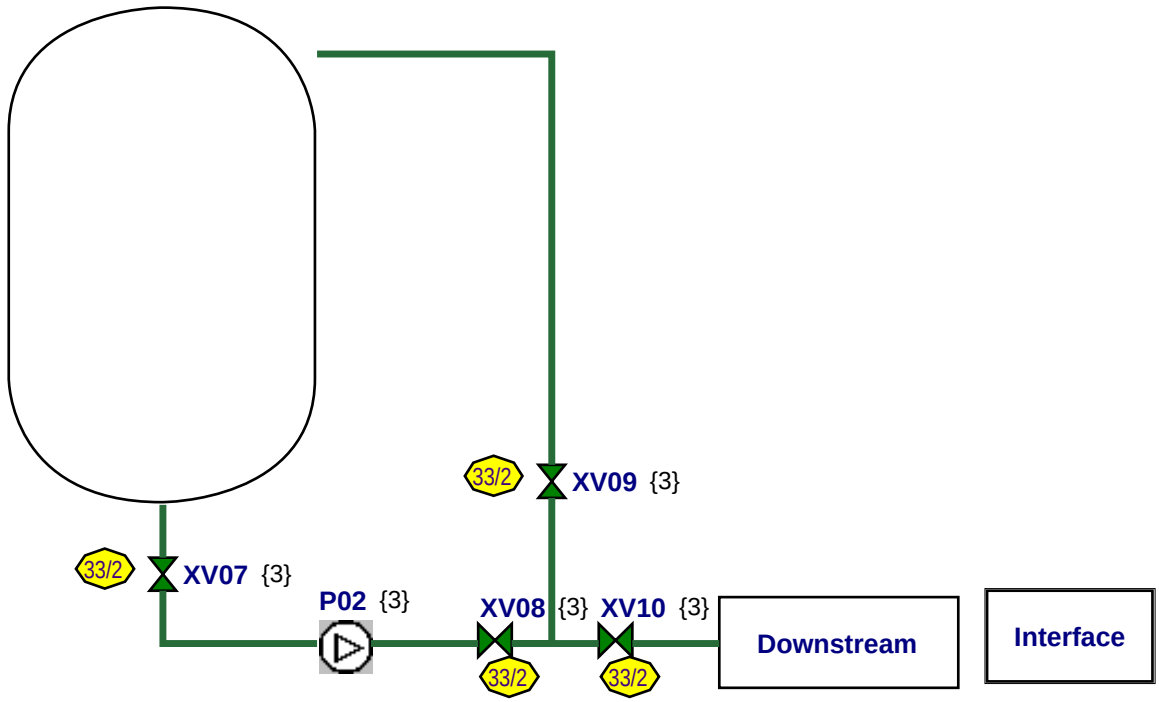


Diagram 6 - em06 Pumping off and Recycling

Variant 2 - Simple

{13}

{13}



Idle

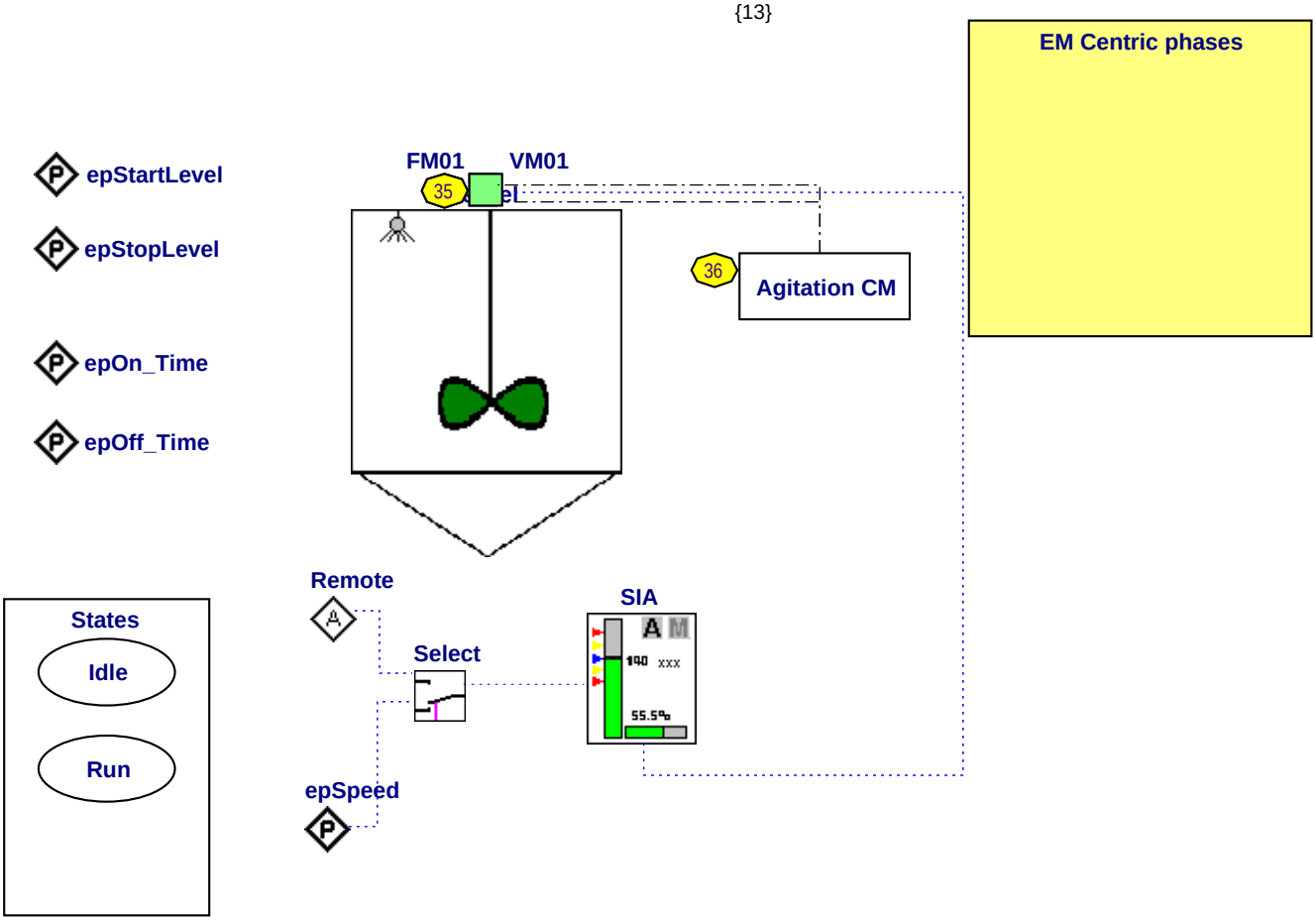
Recycling

Pumping Downstream

Diagram 7 - em07 Stirring

Variant 2 - Simple

{13}



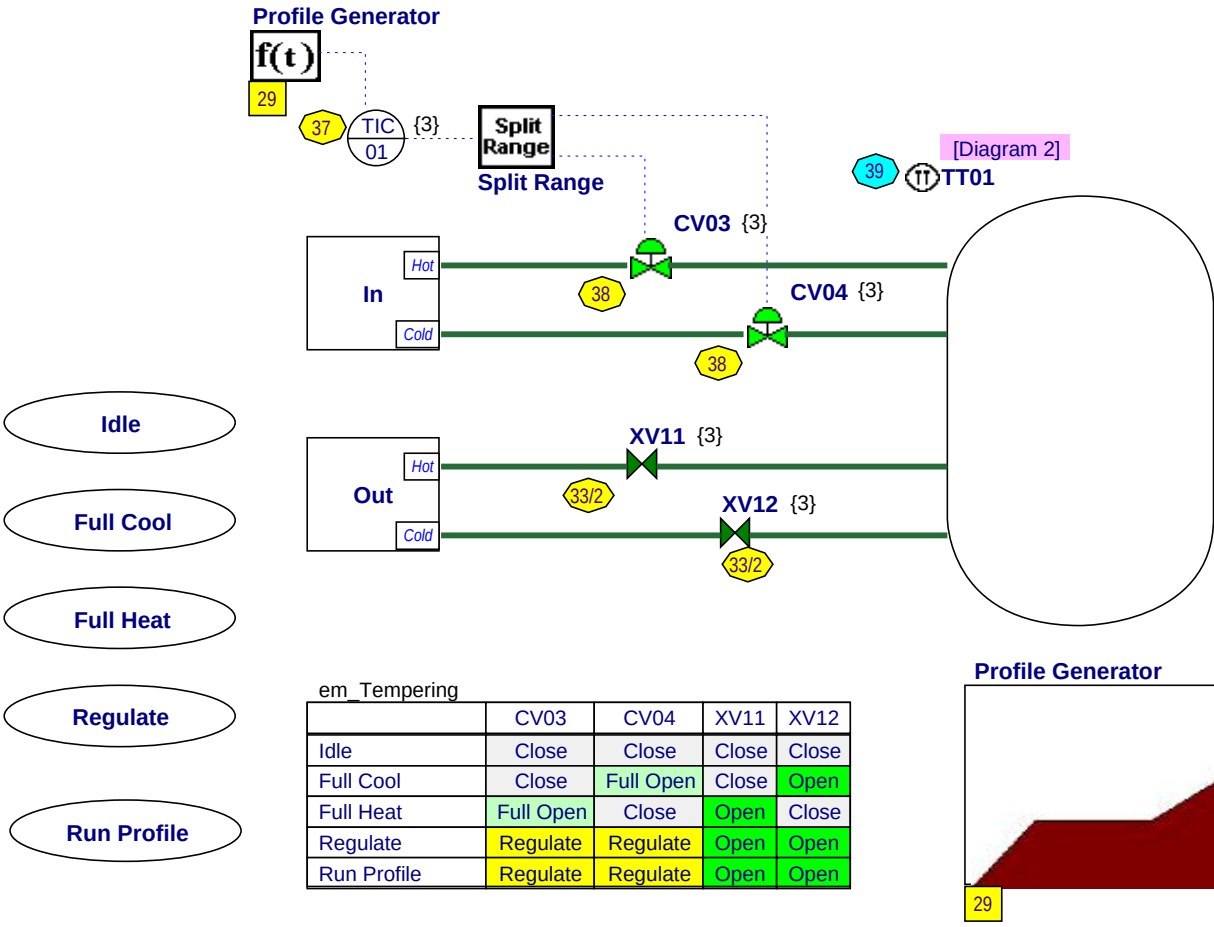
em_Stirring

	Agitation CM	SIA
Idle	Off	Disable
Run	Level Control	Enable

Diagram 8 - em08 Tempering

Variant 2 - Simple

{12}

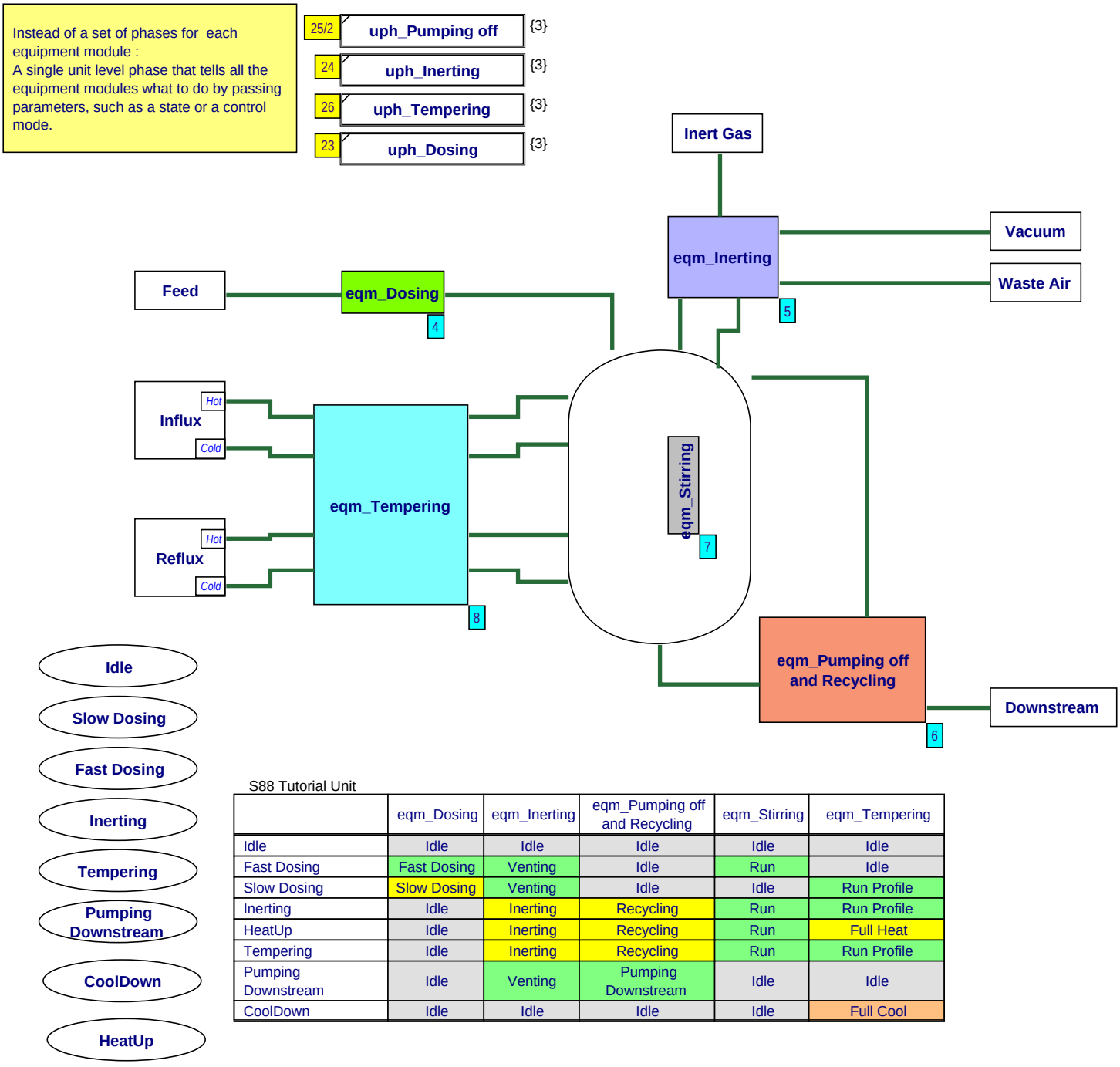


em_Tempering

	CV03	CV04	XV11	XV12
Idle	Close	Close	Close	Close
Full Cool	Close	Full Open	Close	Open
Full Heat	Full Open	Close	Open	Close
Regulate	Regulate	Regulate	Open	Open
Run Profile	Regulate	Regulate	Open	Open

Diagram 9 - em10 Unit

Instead of a set of phases for each equipment module :
A single unit level phase that tells all the equipment modules what to do by passing parameters, such as a state or a control mode.

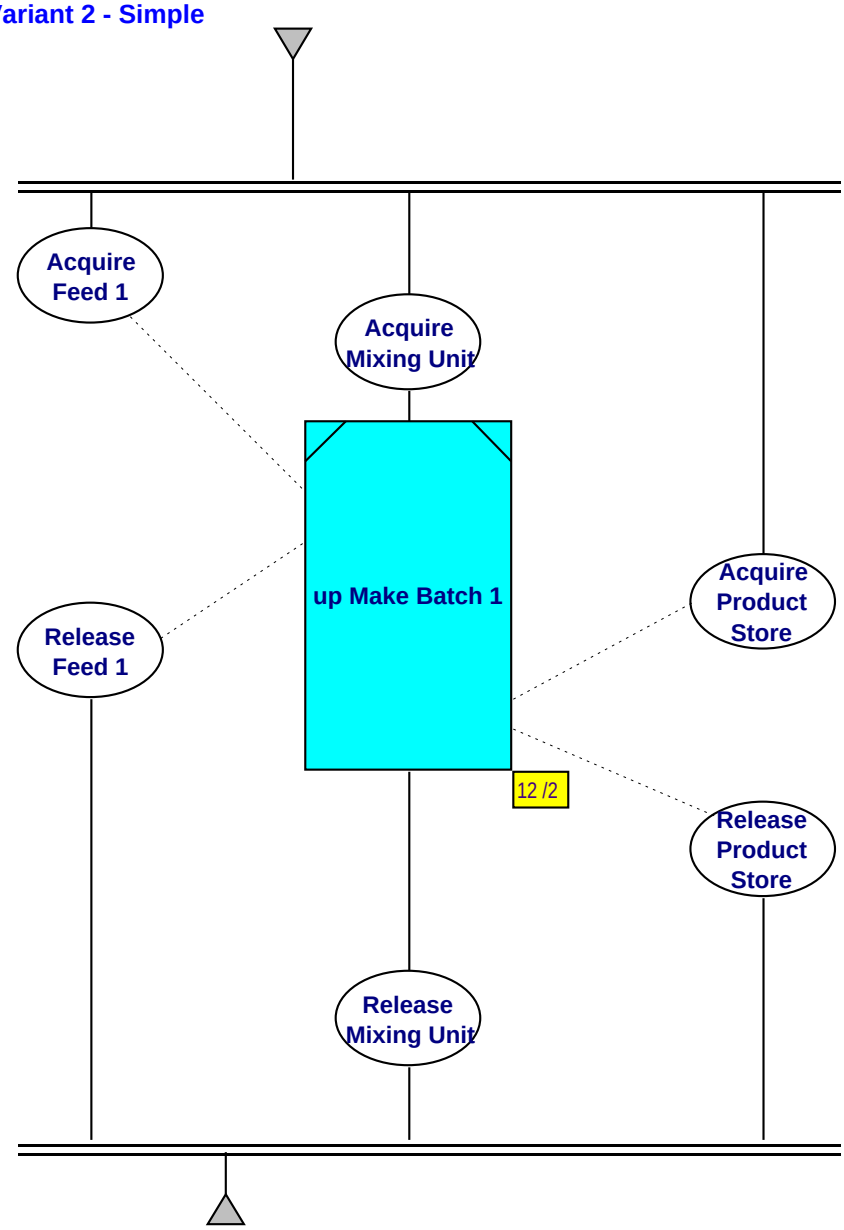


S88 Tutorial Unit

	eqm_Dosing	eqm_Inerting	eqm_Pumping off and Recycling	eqm_Stirring	eqm_Tempering
Idle	Idle	Idle	Idle	Idle	Idle
Fast Dosing	Fast Dosing	Venting	Idle	Run	Idle
Slow Dosing	Slow Dosing	Venting	Idle	Idle	Run Profile
Inerting	Idle	Inerting	Recycling	Run	Run Profile
HeatUp	Idle	Inerting	Recycling	Run	Full Heat
Tempering	Idle	Inerting	Recycling	Run	Run Profile
Pumping Downstream	Idle	Venting	Pumping Downstream	Idle	Idle
CoolDown	Idle	Idle	Idle	Idle	Full Cool

Diagram 10 - rcp Make Batch

Variant 2 - Simple



Note

Feed Storage and Product Storage refers to that part of their common resouces required for the transfer to take place.
In fact, depending in the architecture they may not have to be acquired

Diagram 12 - UP Make Stuff

Variant 2 - Simple

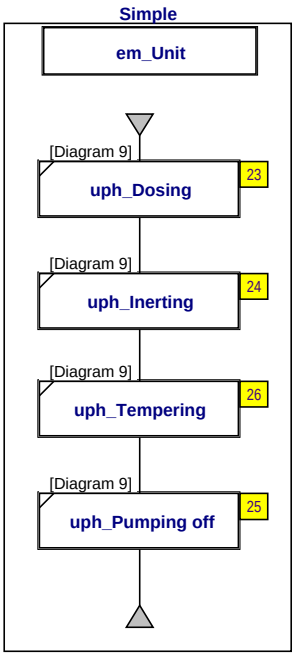


Diagram 23 - uph_Dosing

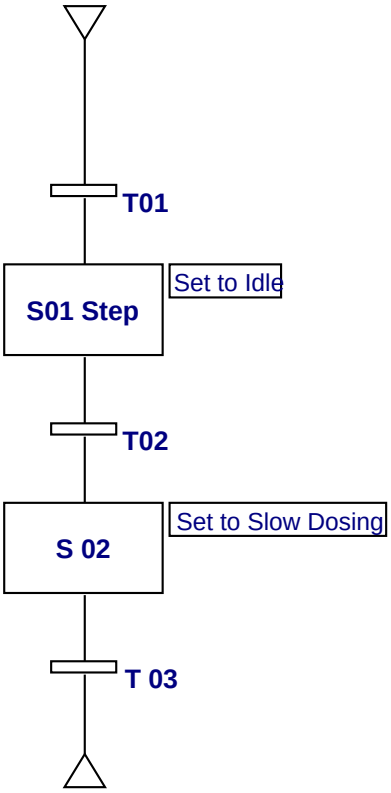


Diagram 24 - uph_Inerting

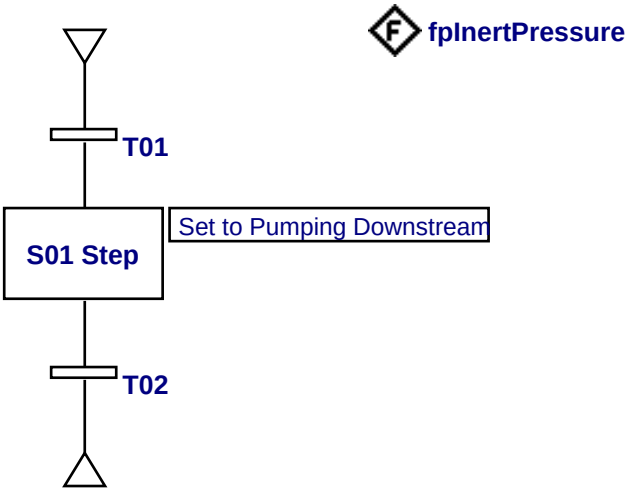


Diagram 25 - uph_Pumping off

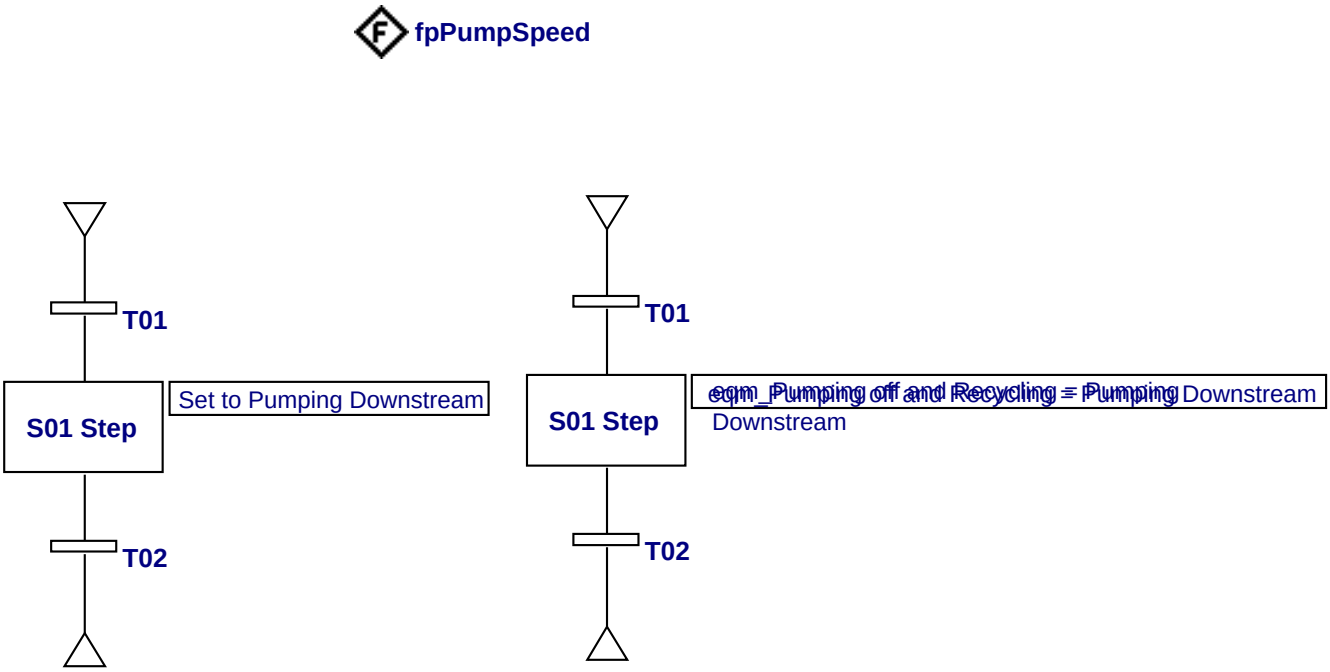


Diagram 25 - uph_Pumping off

Variant 2 - Simple

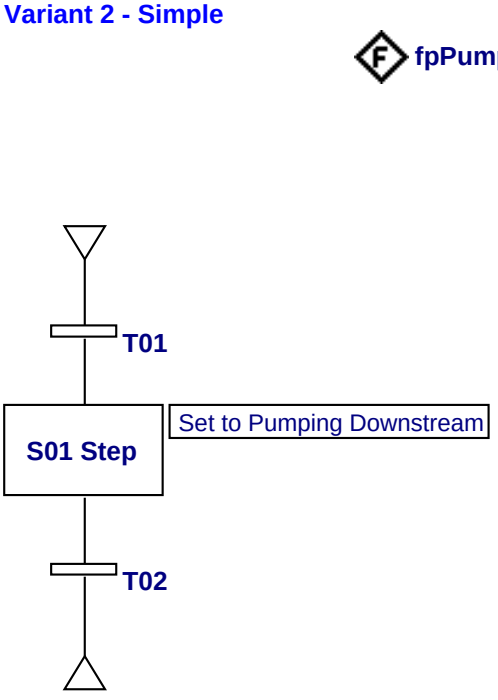
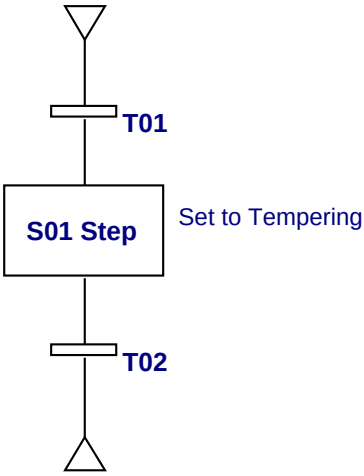


Diagram 26 - uph_Tempering



Description for Diagram 27 - EH_EM

EM Level Exception Handling

Diagram 27 - EH_EM

generic EM Exception handling

Any contained CM failure — 01 **ecm_{Parent}_Failed**

Diagram 29 - Profile Controller

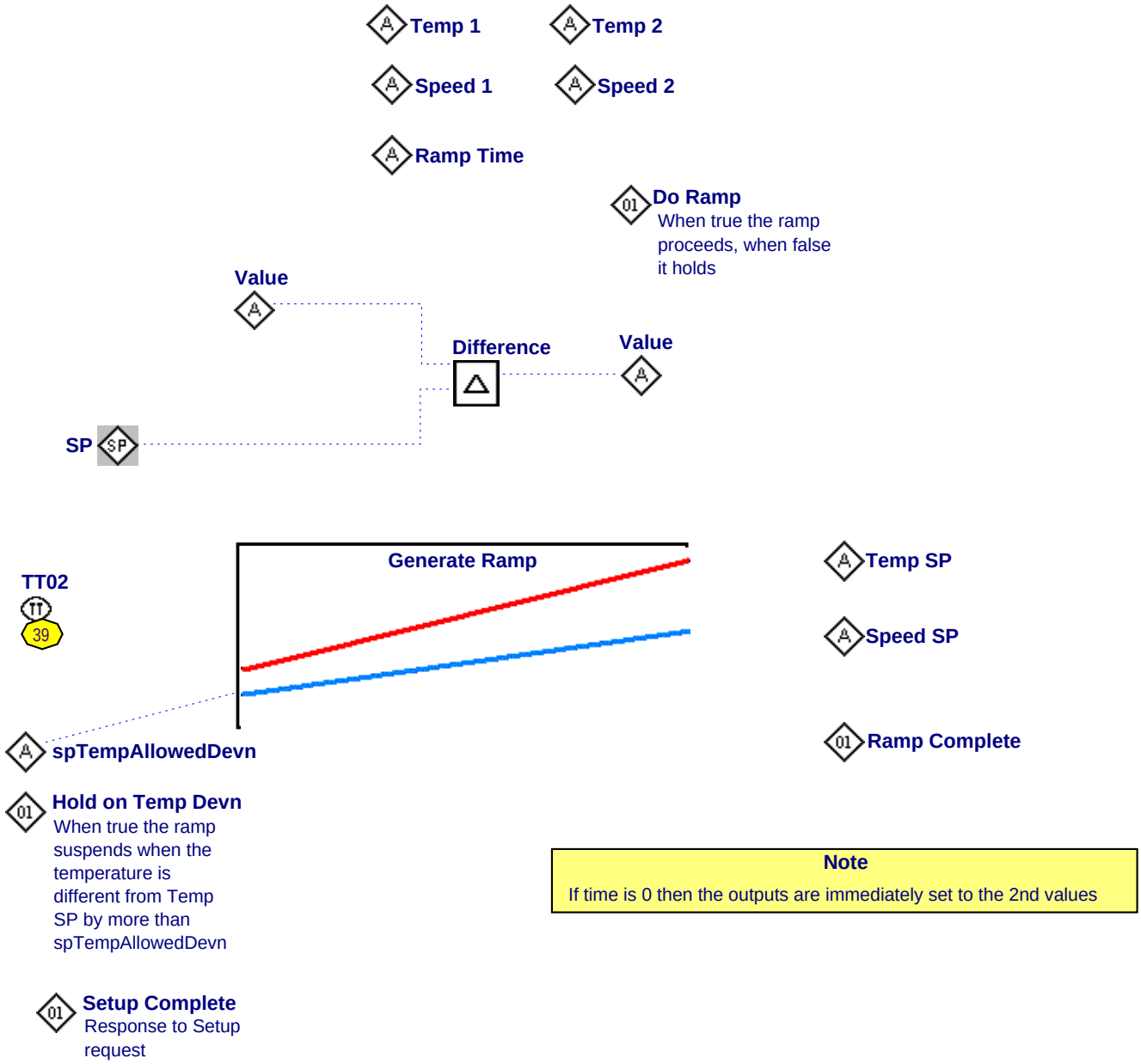


Diagram 30 - Process model Object Mapping

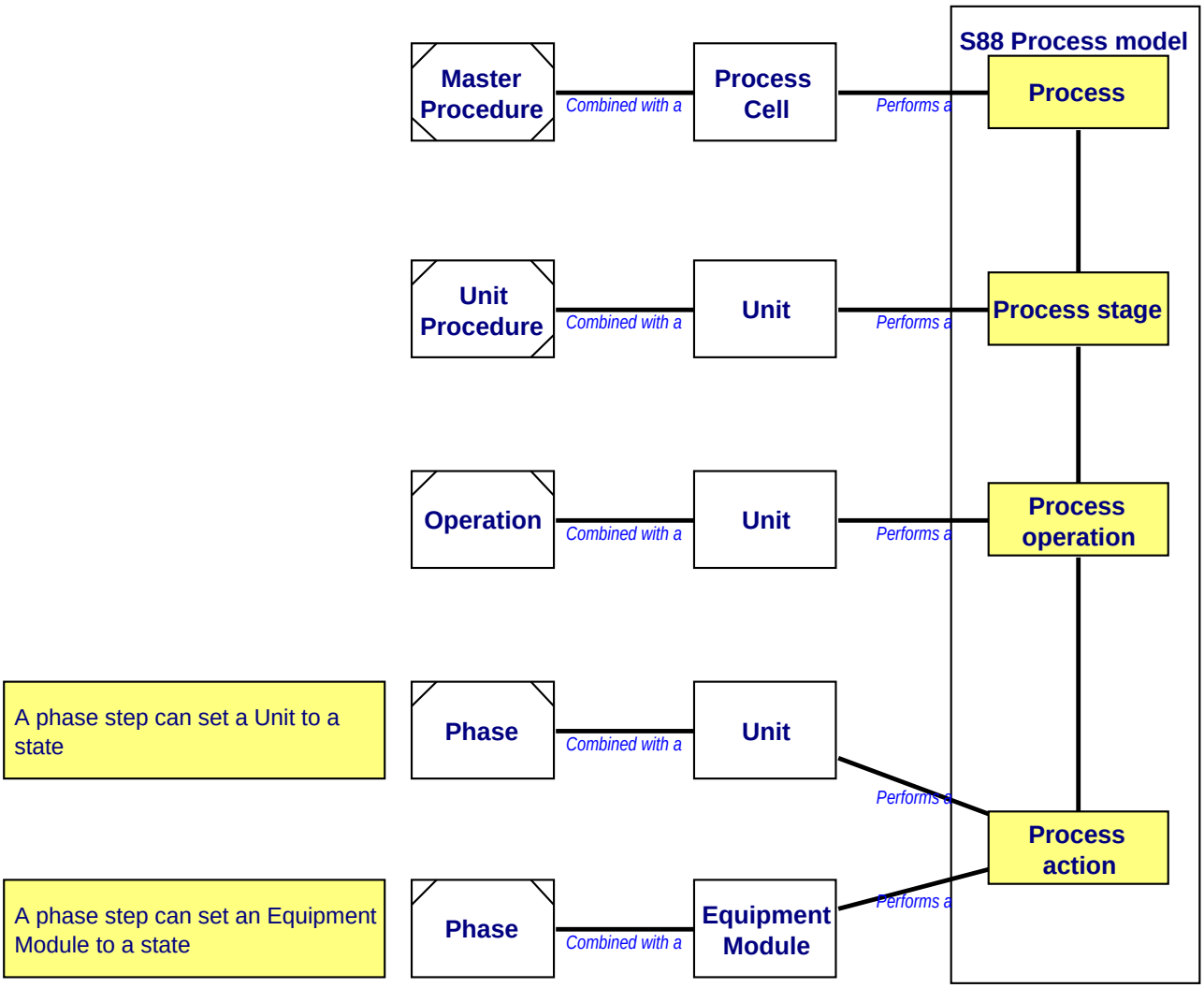


Diagram 30 - Process model Object Mapping

Variant 1 - Typical

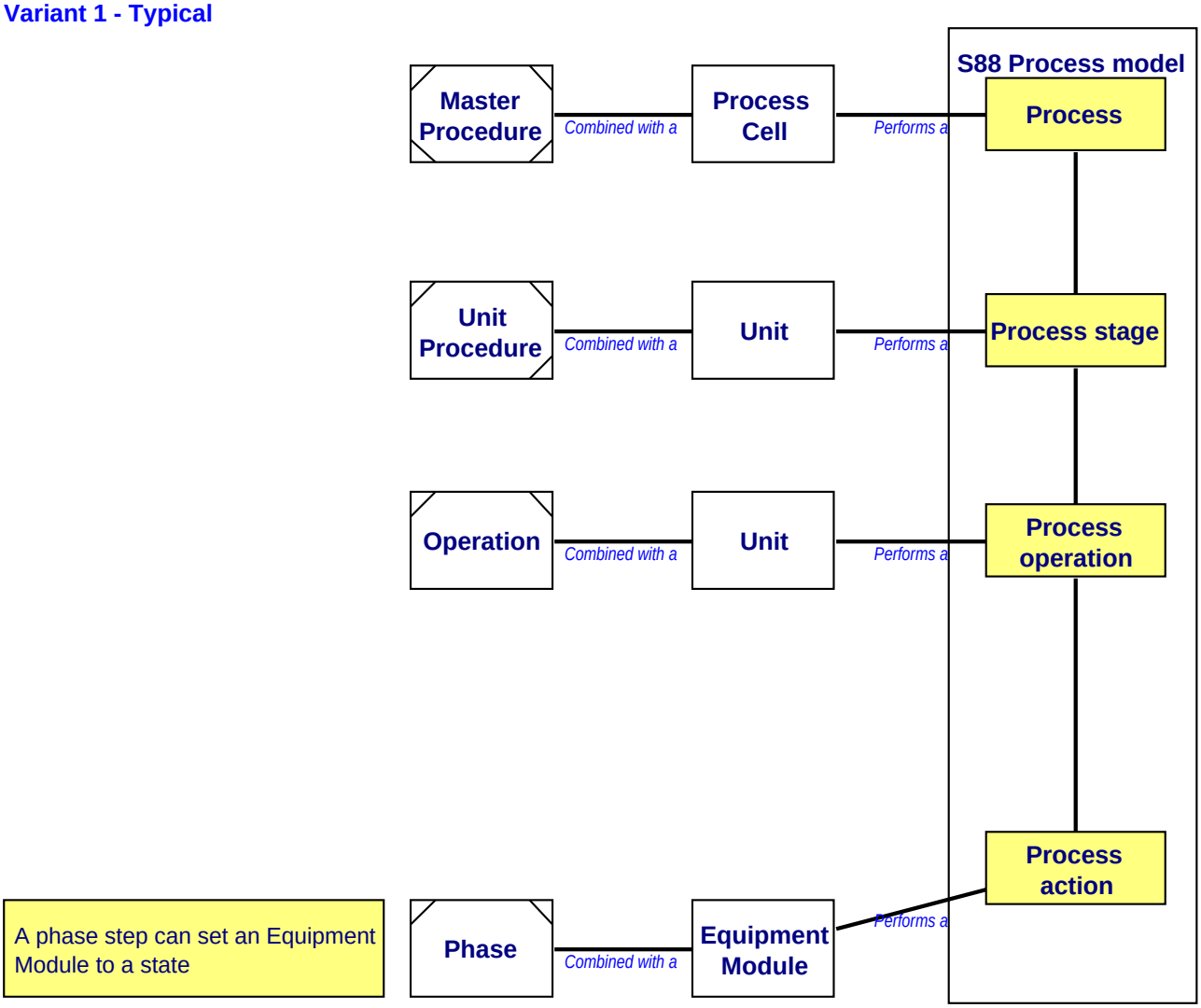
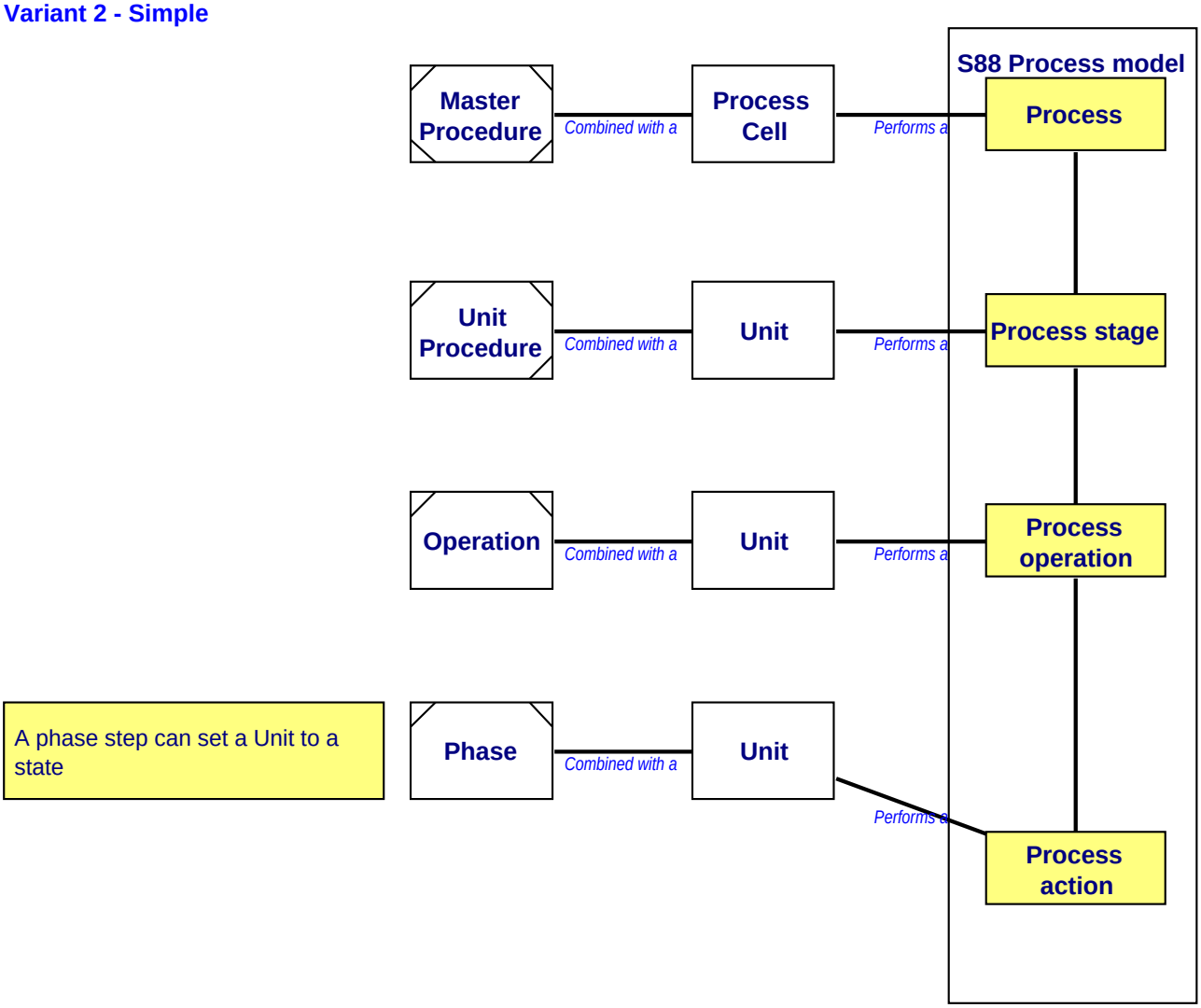


Diagram 30 - Process model Object Mapping

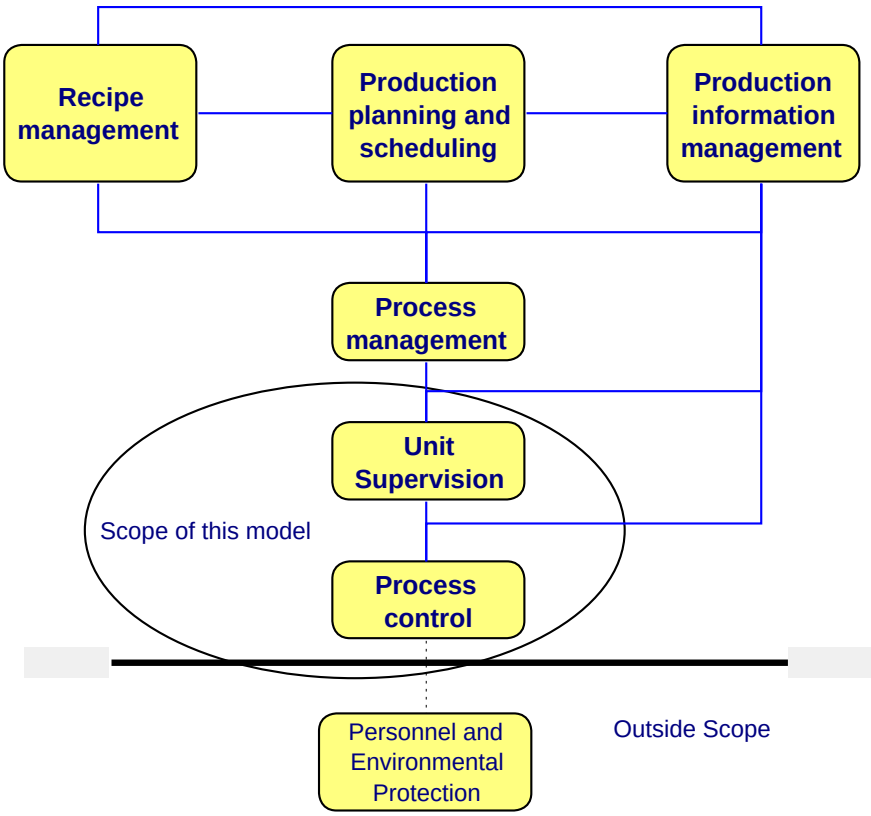
Variant 2 - Simple



Description for Diagram 31 - S88 Control Activity Model

This shows the S88 Control Activity model.
As far as the ControlDraw models go, there are not in general specific objects the relate directly to this.
Defining Process control requirements is the purpose of the ControlDraw model.
Process management is an area that is a function of the Control System in real time, however the ControlDraw model implies much of this.
Recipe management is similar
General requirements for Unit Supervision are implied in the Unit State control, and specific requirements may be identified in some models
Production planning and scheduling is out of scope
Production information management is implicit in the batch logging data in a model.

Diagram 31 - S88 Control Activity Model



Description for Diagram 32 - What is a Recipe Parameter

5.2 Recipe Parameters

While S88 does not use that term, it does use Process Parameter, for example temperature. The Recipe Parameters that I understand are just like that, Set Points that are defined in a master recipe.
There are recipe parameters in the models that simply are not process parameters, for example Exit Running. That is a control flag that is required when calling a phase, but has nothing to do with the process.
Another example, ROUTE
Route is not a recipe parameter.
There are also things that Should have been handled as recipe parameters that are instead being programmed.
Now, ControlDraw has a powerful feature specially designed for handling the way recipe parameters are mapped between the Batch Manager (in this case RS Batch) and the phase logic, but this has not been used.

Diagram 32 - What is a Recipe Parameter

Good Recipe Parameters

A quantity
A Process Variable setting, generally having a min and max value
eg Flow, Temperature, Pressure

Not Recipe Parameters

A flag passed to a phase such as Exit Running
A batch number
A Route

fp Temp
an object in this model representing a Recipe Parameter

Description for Diagram 33 - On Off Valve

Features of the Standard ControlDraw Valve Class

Per S88, A control module is typically a collection of sensors, actuators, other control modules, and associated processing equipment that, from the point of view of control, is operated as a single entity.....for example...(an).. on/off automatic block valve control modules.

The ControlDraw standard valve class is a a 2 position valve with optional position feedback switches, that is operated via commands from automatic or manual logic depending on it's mode.

Features of the Standard ControlDraw On Off Valve

Variants

Cover the instrumentation choices for a valve

The Valve Driver

Travel is timed in each direction. Timeout causes Fail to Open or Fail to Close
Standard Auto/Manual.

Alarms

Fail

Modes

Interlock

Overrides

If set to the limit switch is ignored

Valve status

This is used by control logic when it needs to know what the valve is up to.
0 = Closed
1 = Open
2 = Moving
3 = Failed

Travel Timers

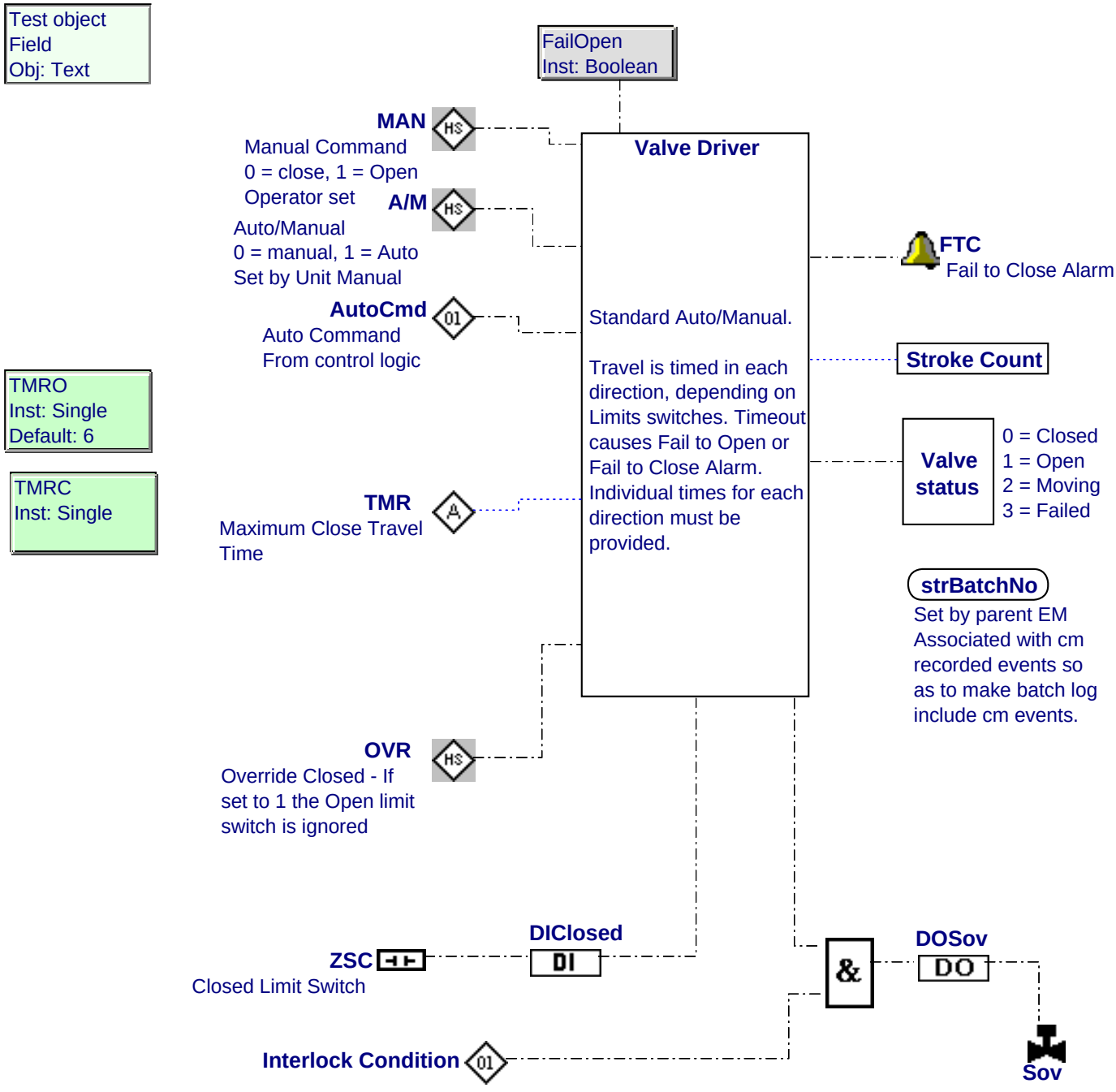
The

Stroke Count

Typically maintenance functions need to have a measure of the stress on a device, this provides a suitable count. It is best done in basic control as it is a simple function that can be handled at a low level

Diagram 33 - On Off Valve

Variant 2 - Closed LS



Type
Inst: Text

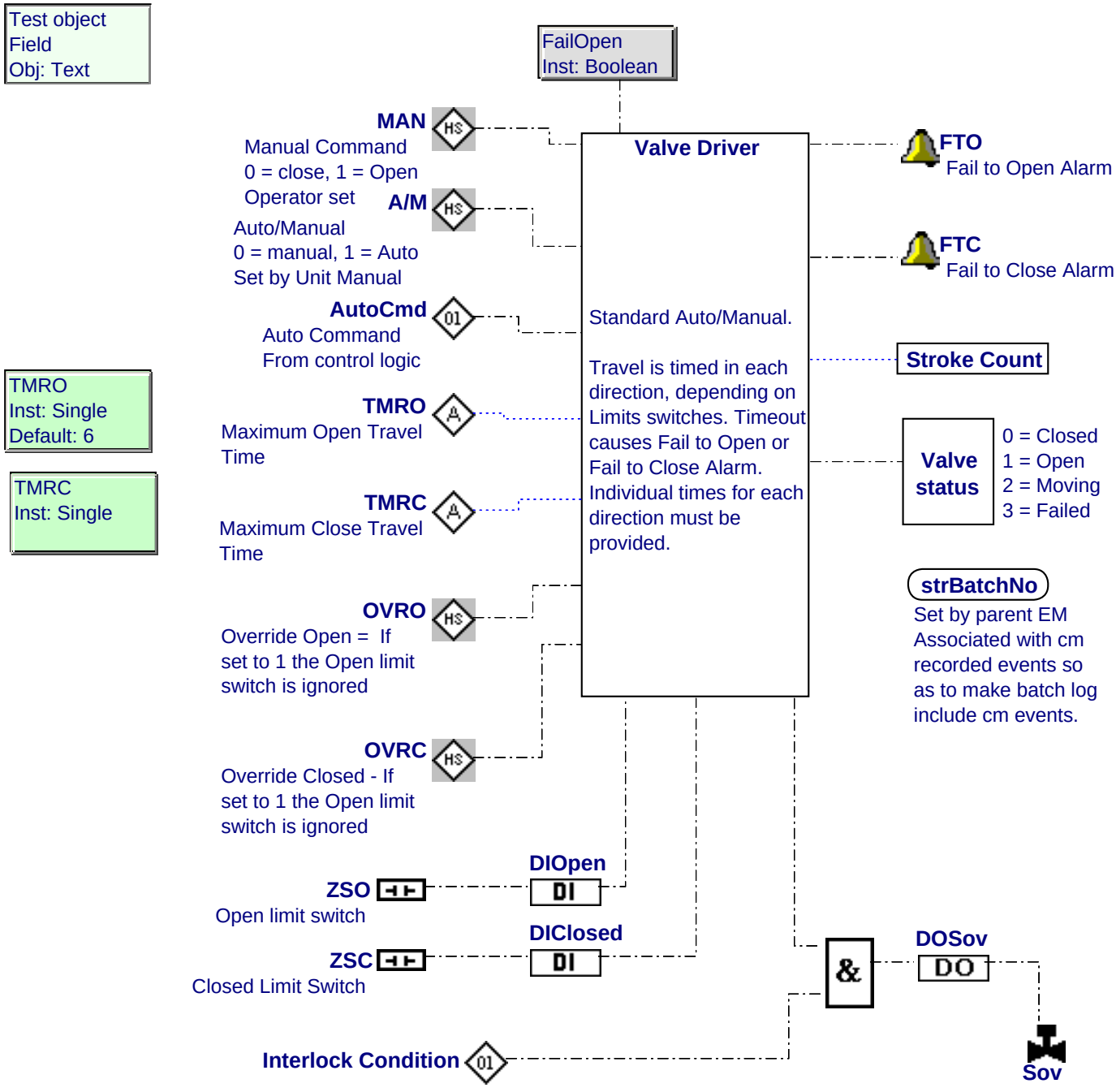
Signed
Test Sheet
Table

List of Variants

	1-Open LS	2-Closed LS	3-2 Limit Switches	4-No limit switches
DIClosed	{Excluded}			{Excluded}
DIOpen		{Excluded}		{Excluded}
FTC	{Excluded}			{Excluded}
FTO		{Excluded}		{Excluded}
OVRC	{Excluded}	OVR		{Excluded}
OVRO	OVR	{Excluded}		{Excluded}
TMRC	{Excluded}	TMR		{Excluded}
TMRO	TMR	{Excluded}		{Excluded}
ZSC	{Excluded}			{Excluded}
ZSO		{Excluded}		{Excluded}

Diagram 33 - On Off Valve

Variant 3 - 2 Limit Switches



Type
Inst: Text

Signed
Test Sheet
Table

List of Variants

	1-Open LS	2-Closed LS	3-2 Limit Switches	4-No limit switches
DIClosed	{Excluded}			{Excluded}
DIOpen		{Excluded}		{Excluded}
FTC	{Excluded}			{Excluded}
FTO		{Excluded}		{Excluded}
OVRC	{Excluded}	OVR		{Excluded}
OVRO	OVR	{Excluded}		{Excluded}
TMRC	{Excluded}	TMR		{Excluded}
TMRO	TMR	{Excluded}		{Excluded}
ZSC	{Excluded}			{Excluded}
ZSO		{Excluded}		{Excluded}

Diagram 34 - Fixed Speed Motor

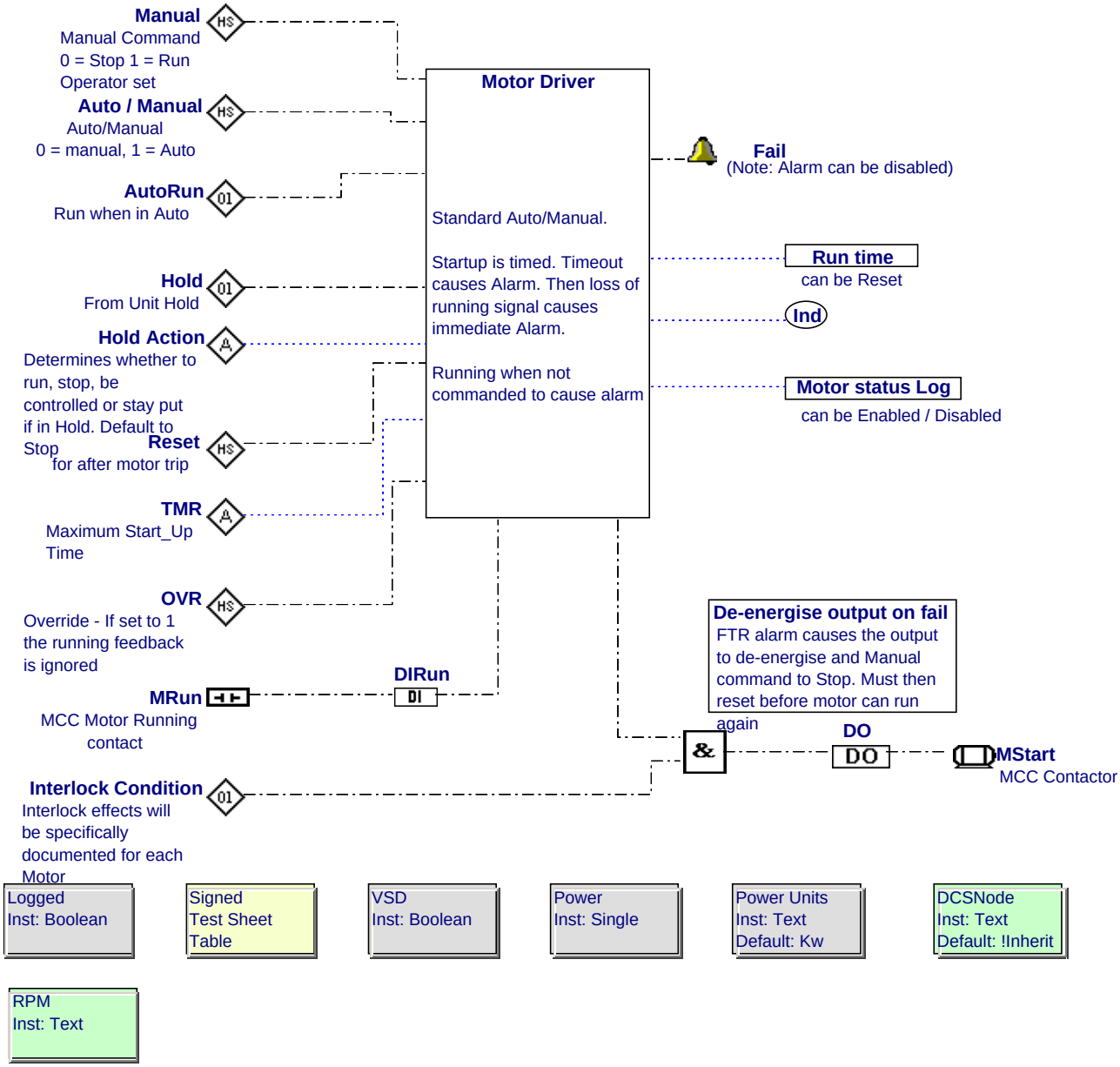


Diagram 35 - Variable Speed motor

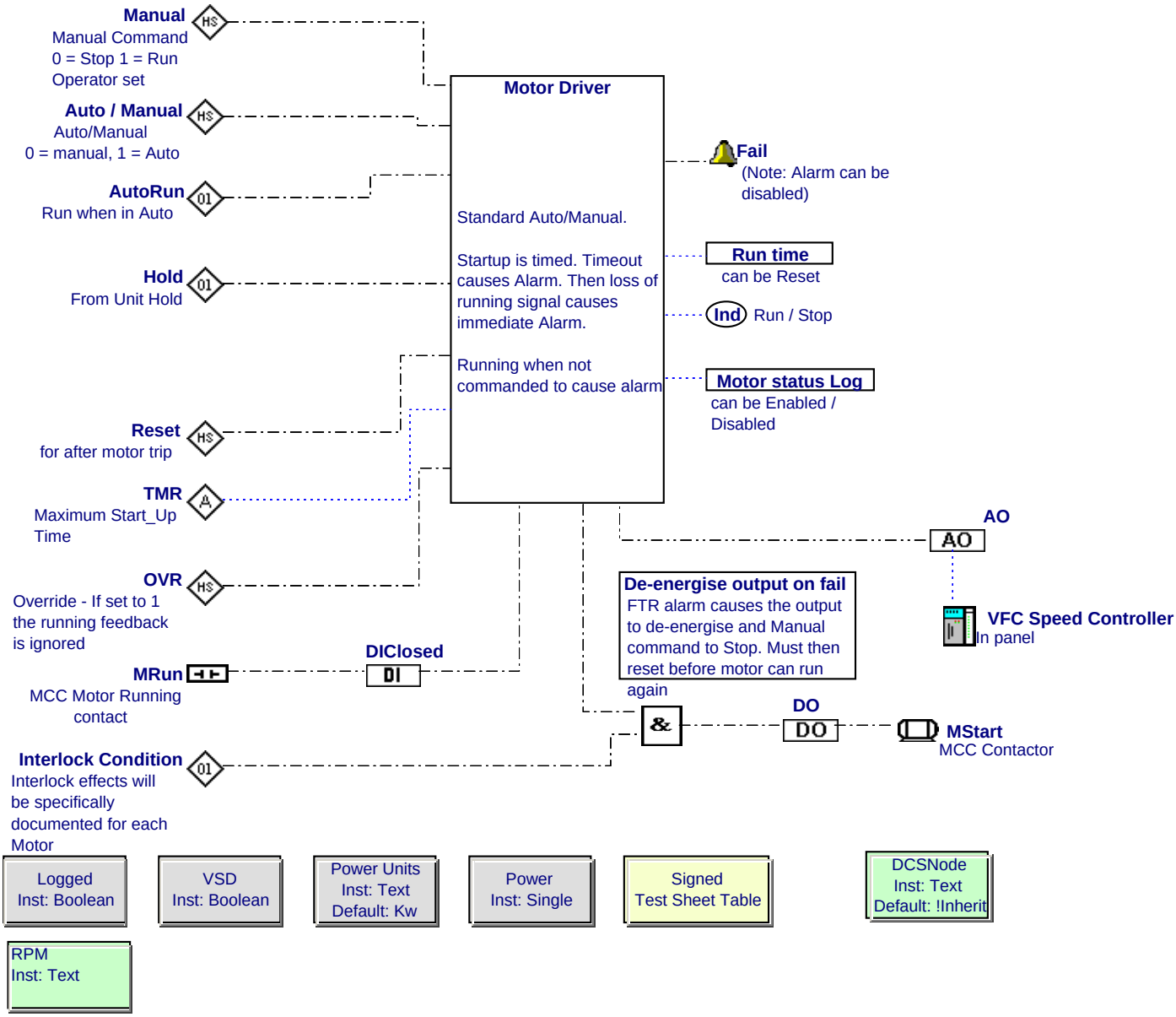
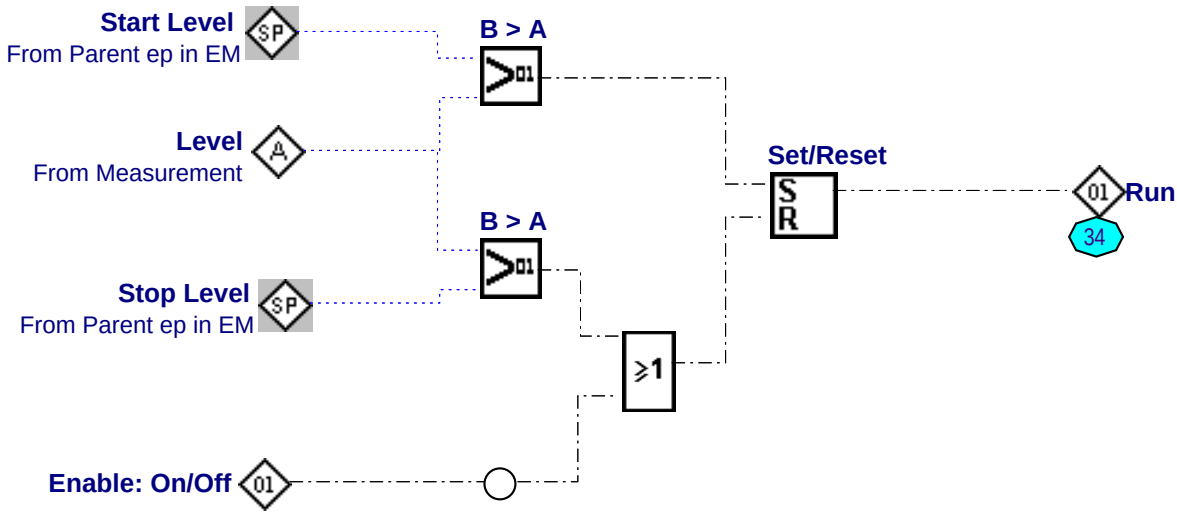
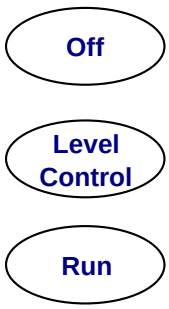


Diagram 36 - cm Agitator Control

Parent Symbols:
7 - em07 Stirring
.... , Agitation CM

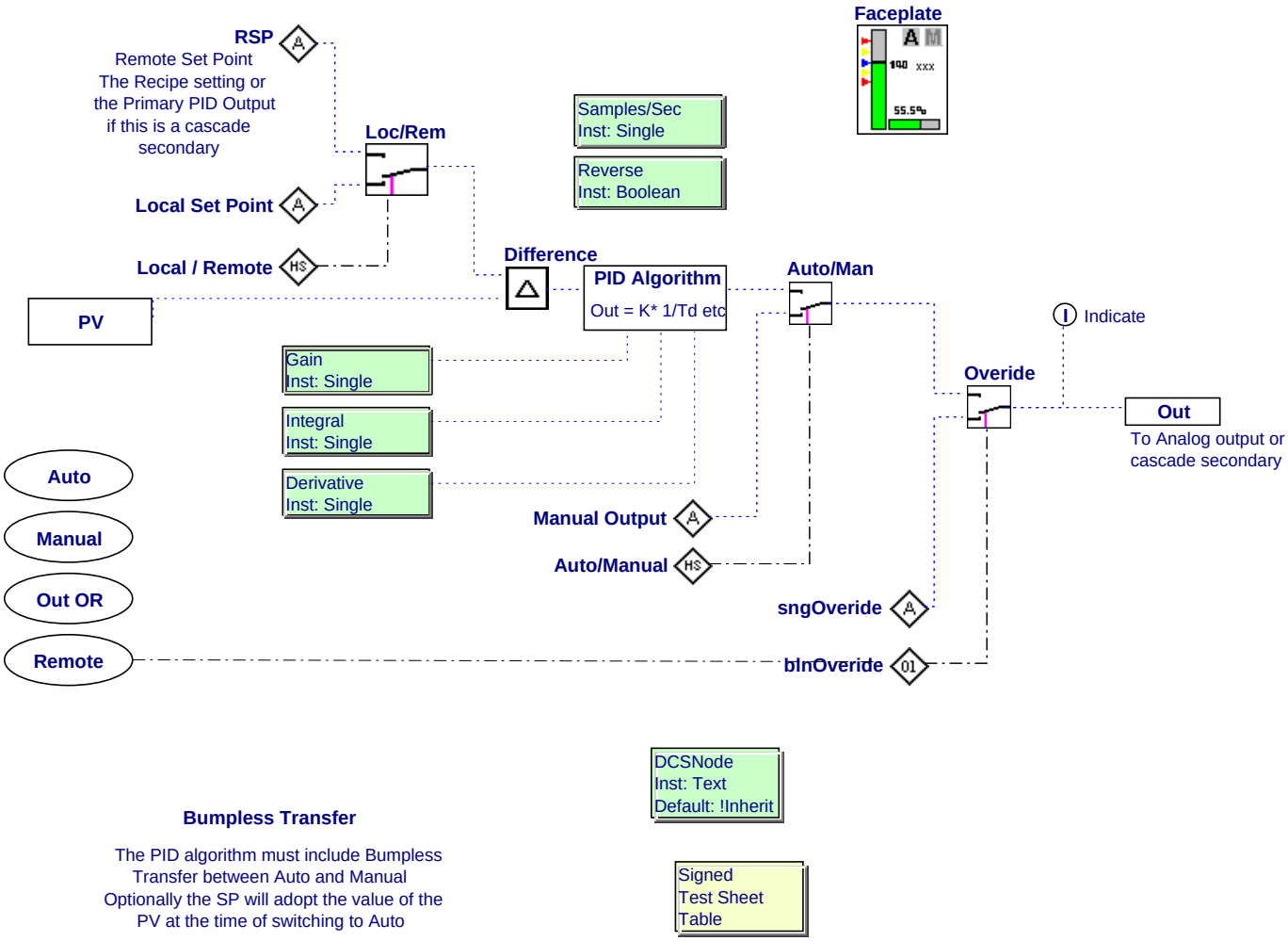




Description for Diagram 37 - Standard PID Loop

A module for providing PID Control. PCS supplier standard expected.

Diagram 37 - Standard PID Loop



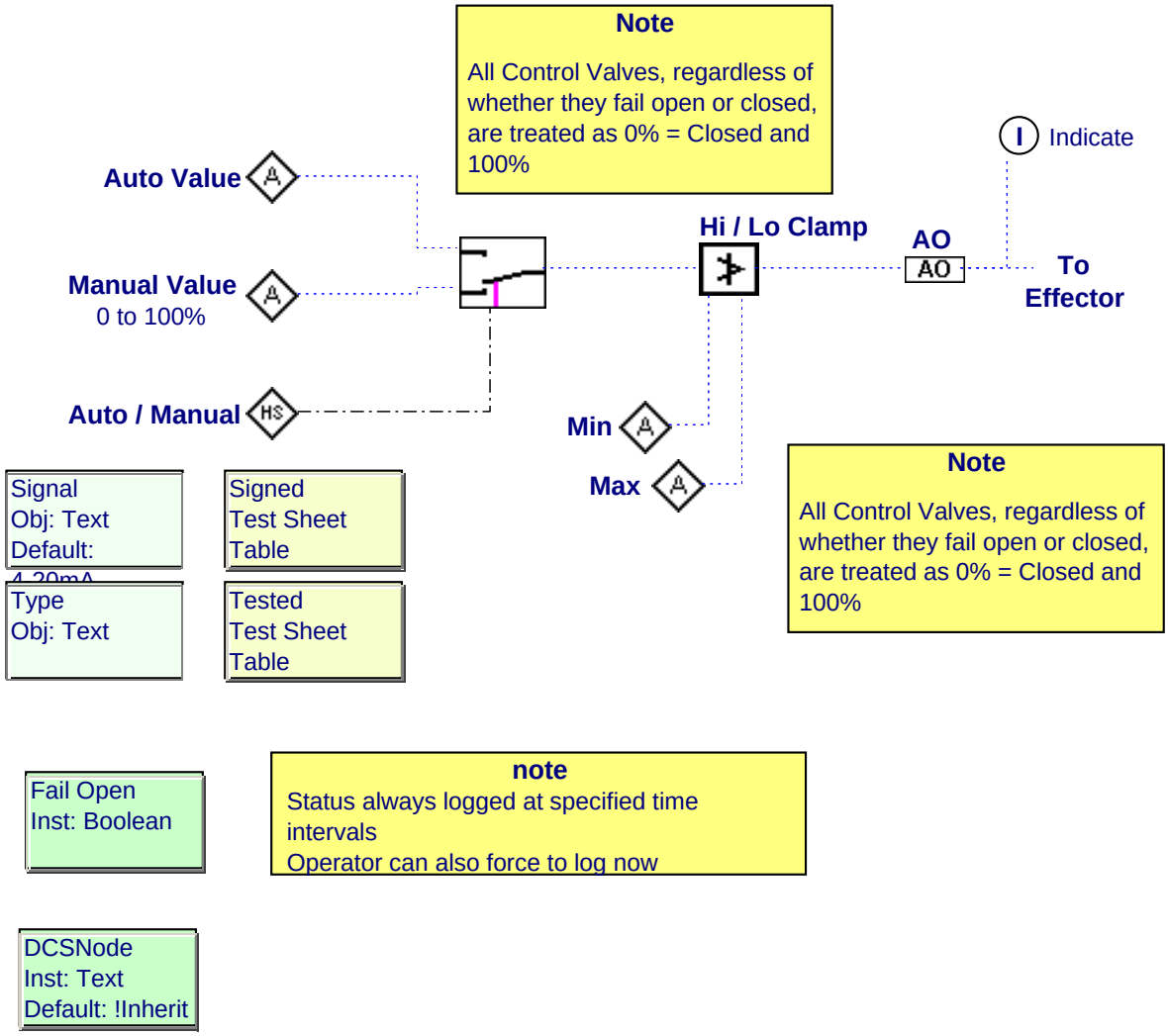
Bumpless Transfer

The PID algorithm must include Bumpless Transfer between Auto and Manual
Optionally the SP will adopt the value of the PV at the time of switching to Auto

Description for Diagram 38 - Control Valve

A module for driving a control valve, PCS supplier standard expected.

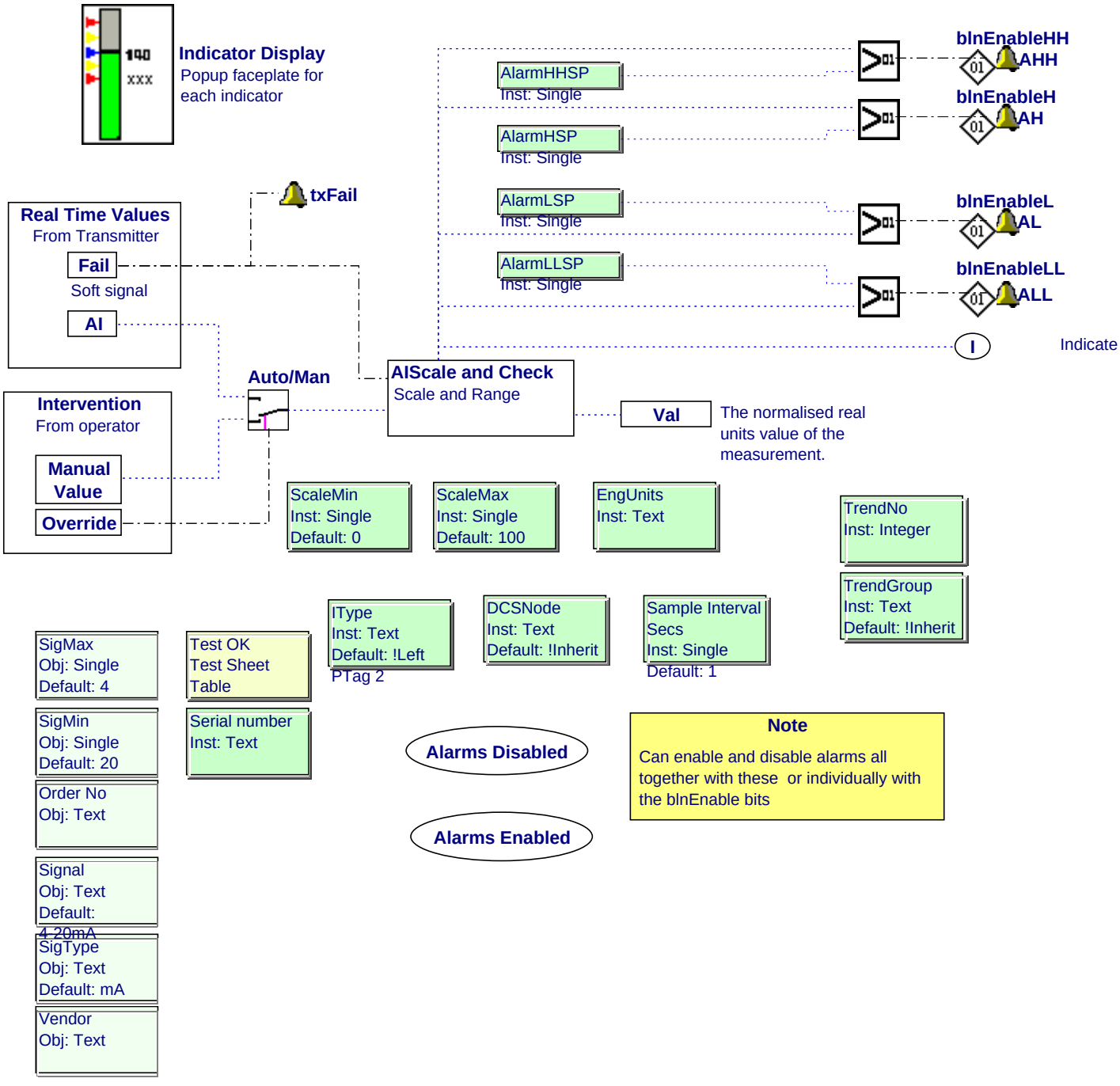
Diagram 38 - Control Valve



Description for Diagram 39 - Analog Input from Transmitter

A module for reading from a transmitter, PCS supplier standard expected.

Diagram 39 - Analog Input from Transmitter



Data Report: Recipe Formula Value

RealTag	DataVersion	EU	Min	Value	Max	AllowChange	Defer Level	IsDefered	Defer Tag	Scaleable
S88ST.em_Unit.uph_Inerting.fpInertPressure	237					☐		☐		☐
S88ST.em_Unit.uph_Pumping off.fpPumpSpeed	179					☐		☐		☐
S88ST.UP Make Simple.uph_Inerting.fpInertPressure	237					☐		☐		☐
S88ST.UP Make Simple.uph_Pumping off.fpPumpSpeed	179					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Prof 2.rpRamp Time	53					☐	1/OP	☑	Ramp Time1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Prof 2.rpSpeed 1	53					☐	1/OP	☑	Speed 1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Prof 2.rpSpeed 2	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Prof 2.rpTemp 1	53		10	54	200	☐	1/OP	☑	Temp 1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Prof 2.rpTemp 2	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Profile 1.rpRamp Time	53					☐	1/OP	☑	Ramp Time1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Profile 1.rpSpeed 1	53					☐	1/OP	☑	Speed 1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Profile 1.rpSpeed 2	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Profile 1.rpTemp 1	53		10	54	200	☐	1/OP	☑	Temp 1	☐
Simpler Recipe.up Make Batch 1.op Make Batch.ph Mix and Temperature Profile 1.rpTemp 2	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.Ramp Time1	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.Speed 1	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.Speed 2	53					☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.Temp 1	60		10	54	200	☐		☐		☐
Simpler Recipe.up Make Batch 1.op Make Batch.Temp 2	53					☐		☐		☐

Data Report: Control System IOList

ObjectTag	page	PageID	Page Tag	RealTag	DCSNode	IO Type	Card	Channel
csAI	39	13	AI	S88ST.TT01.AI		AI		
csAO	38	14	AO	S88ST.CV02.AO		AO		
csAO	38	14	AO	S88ST.CV01.AO		AO		
csAO	38	14	AO	S88ST.CV03.AO		AO		
csAO	38	14	AO	S88ST.CV04.AO		AO		
csAO	35	53	AO	S88ST.VM01.AO		AO		
csDI	33	21	DIClosed	S88ST.XV05.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV06.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV04.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV07.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV10.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV08.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV09.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV11.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV12.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV01.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV02.DIClosed		DI		
csDI	33	21	DIClosed	S88ST.XV03.DIClosed		DI		
csDI	35	53	DIClosed	S88ST.VM01.DIClosed		DI		
csDI	33	21	DIOpen	S88ST.XV04.DIOpen		DI		
csDI	34	31	DIRun	S88ST.PMP01.DIRun		DI		
csDI	34	31	DIRun	S88ST.FM01.DIRun		DI		
csDI	40	79	DIst	S88ST.WT01.DIst		DI		
csDI	40	79	DIwt	S88ST.WT01.DIwt		DI		
csDO	34	31	DO	S88ST.PMP01.DO		DO		
csDO	34	31	DO	S88ST.FM01.DO		DO		
csDO	35	53	DO	S88ST.VM01.DO		DO		
csDO	33	21	DOSov	S88ST.XV05.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV06.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV04.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV07.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV10.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV08.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV09.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV11.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV12.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV01.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV02.DOSov		DO		
csDO	33	21	DOSov	S88ST.XV03.DOSov		DO		
csSI	40	79	SI	S88ST.WT01.SI		SI		