SIEMENS

Application description • 10/2015

Specification of the technical function “Discharge”

SIMATIC PCS 7 / Functional specification

https://support.industry.siemens.com/cs/ww/en/view/33412955

Warranty and liability

Note

The Application Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Application Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible for ensuring that the described products are used correctly. These application examples do not relieve you of the responsibility to use safe practices in application, installation, operation and maintenance. When using these Application Examples, you recognize that we cannot be made liable for any damage/claims beyond the liability clause described. We reserve the right to make changes to these Application Examples at any time without prior notice.
If there are any deviations between the recommendations provided in these application examples and other Siemens publications − e.g. Catalogs − the contents of the other documents have priority.

We do not accept any liability for the information contained in this document.

Any claims against us – based on whatever legal reason – resulting from the use of the examples, information, programs, engineering and performance data etc., described in this Application Example shall be excluded. Such an exclusion shall not apply in the case of mandatory liability, e.g. under the German Product Liability Act (“Produkthaftungsgesetz”), in case of intent, gross negligence, or injury of life, body or health, guarantee for the quality of a product, fraudulent concealment of a deficiency or breach of a condition which goes to the root of the contract (“wesentliche Vertragspflichten”). The damages for a breach of a substantial contractual obligation are, however, limited to the foreseeable damage, typical for the type of contract, except in the event of intent or gross negligence or injury to life, body or health. The above provisions do not imply a change of the burden of proof to your detriment.

Any form of duplication or distribution of these Application Examples or excerpts hereof is prohibited without the expressed consent of Siemens Industry Sector.

© Siemens AG 2015 All rights reserved

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens’ products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit http://www.siemens.com/industrialsecurity.

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit http://support.automation.siemens.com.

Table of contents

Warranty and liability **2**

1 Introduction **4**

1.1 Terminology 4
1.2 P&I Diagram 4
1.3 CM configuration 5

2 Execution behavior **6**

3 Parameter description **8**

3.1 Control strategies 8
3.2 Setpoints (SP_) 8
3.3 Process values (PV_xy) 8
3.4 Parameters (IN_xy) 9
3.5 Timers (TI_x) 9
3.6 Control values (QV_xy) 9
3.7 Operator / instruction texts 10
3.8 Position texts 10
3.9 Connections 10
3.10 Standard SFC type messages 11
3.11 Individual messages 12

4 Control strategy 1 – „Discharge“ **13**

5 Control strategy 2 – „Drain“ **21**

6 Control strategy 3 – „Circulation“ **22**

7 Related literature **23**

8 History **23**

© Siemens AG 2015 All rights reserved

1 Introduction

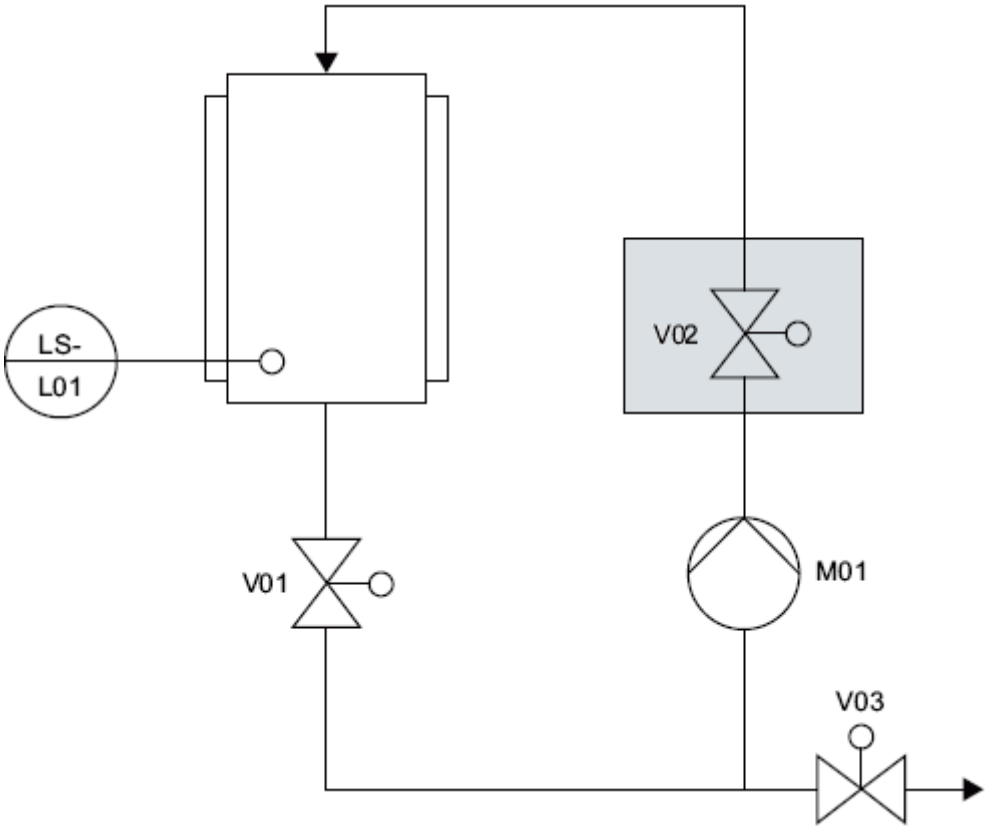
1.1 Terminology

Table 1-1

Term / Abbreviation	Description
CM	Control Module
CTRL_PID	Software block for controllers
EM	Equipment Module
MOTOR	Software block for motors with a control signal
VALVE	Software block for valves with a control signal

1.2 P&I Diagram

Figure 1-1



Note The optional V02 measuring point is grayed out.

Copyright © Siemens AG 2015 All rights reserved

1.3 CM configuration

Table 1-2

Name	I/O name	CM	Description	optional
M01	M01	MOTOR	Pump	
V01	V01	VALVE	Bottom valve	
V02	V02	VALVE	Circulating valve	x
V03	V03	VALVE	Drain valve	

Copyright © Siemens AG 2015 All rights reserved

2 Execution behavior

It is important to transfer products between vessels, especially when different products are produced. Sometimes it is necessary to transfer the complete content of the vessel, sometimes only a certain amount. An example of a vessel is a buffer or a head tank. The target vessel to which the various materials or products are transferred is usually a reactor or a centrifuge.

For this transfer, this equipment module (EM) controls the removal of the product or input material from a tank.

Control Strategy 1: „Discharge“

The discharge control strategy discharges a certain amount of material from the vessel.

It receives a request to open the discharge path by another technical function (e.g., “Dosing with valve control”) and keeps it open until the request is cancelled. This ensures a precisely discharged amount that is controlled by the Dosing with control valve EM.

If the vessel is empty before the request is retracted, a message is sent and the EM changes to Hold.

Control Strategy 2: „Drain“

The drain control strategy empties the entire vessel. Once the vessel is empty, the EM receives the signal to complete over a process value.

Control Strategy 3: „Circulation“

Some products must be kept constantly on the move to prevent them from hardening. To achieve this, the product is taken from the vessel and returned to the vessel by a pump. A circulation is produced that keeps the product moving constantly.

General

The Control Modules (CM) are checked to make sure they are functioning failure-free. Hold conditions (LOCKERROR):

- CM in fault/error state

Copyright © Siemens AG 2015 All rights reserved

Summary of the states

The following table illustrates when sequences correspond to each other in the control strategies.

Table 2-1

State	Control Strategy 1 Discharge	Control Strategy 2 Drain	Control Strategy 3 Circulation
Starting	X	X_1	X_1
Run	X	X	X
Completing	X	X_1	X_1
Ended			
Holding	X	X_1	X_1
Held	X	X_1	X_1
Holding error	X	X_1	X_1
Held error	X_{held}	X_1	X_1
Resuming	X	X_1	X_1
Resuming error	$X_{resuming}$	X_1	X_1
Stopping	$X_{completing}$	X_1	X_1
Stopped			
Aborting	X	X_1	X_1
Aborted			

Legend

X:	Sequence exists
X_1:	As sequence in control strategy 1
X_{xyz}:	As xyz state in the same control strategy

Operating status: „Idle“

Starting the EM is possible only when starting is enabled.

Manual operation of the CMs in the idle state is possible.

Figure 2-1

Copyright © Siemens AG 2015 All rights reserved

3 Parameter description

3.1 Control strategies

Table 3-1

Nummer	Name
1	Discharge
2	Drain
3	Circulation

3.2 Setpoints (SP_)

Table 3-2

Control parameter	Unit	Setpoint change in status running	Type of travel									
			1	2	3	4	5	6	7	8	9	10
Circulation_Time (SP_CIRC_TIME) (Umpumpzeit)	min				X							

Legend

Circulation_Time:	Circulation time in minutes

3.3 Process values (PV_xy)

Table 3-3

Name	Data type	Unit	I/O name
Circulation_Time_Sec	Analog	sec	PV_TANK_CIRC_TIME_SEC
Settle_Time_Sec	Analog	sec	PV_SETL_TIME
Tank_Number_OK	Binary		PV_TANK_NO_OK
Tank_Empty	Binary		PV_TANK_EMPTY

Legend

Circulation_Time_Sec:	Circulation time in seconds
Settle_Time_Sec:	Settling time in seconds
Tank_Number_OK:	Request from EM Dosing
Tank_Empty:	Vessel is empty

Copyright © Siemens AG 2015 All rights reserved

3.4 Parameters (IN_xy)

Table 3-4

Name	Data type	Unit	I/O name
Settling_Time	Analog	sec	IN_SETTLE_TIME

Legende

Settling_Time: Settling time when emptying

3.5 Timers (TI_x)

External timers are used in this EM.

3.6 Control values (QV_xy)

Table 3-5

Name	Data type	I/O name
Enable_CM_Manual	Binary	QV_EN_CM_MAN
Enable_CS	Integer	QV_EN_CS
Start_Circ_Time	Binary	QV_START_CIRC_TIME
Reset_Circ_Time	Binary	QV_RESET_CIRC_TIME
Start_Settle_Time	Binary	QV_START_SETTL_TIME
Reset_Settle_Time	Binary	QV_RESET_SETTL_TIME
Settle Time	Real	QV_SETTLE_TIME

Legend

Enable_CM_Manual: Release for changing to manual mode for all CMs

Enable_CS: Enable for control strategy change

Start_Circ_Time: Start command for external timer

Reset_Circ_Time: Reset external timer

Start_Settle_Time: Start command for external timer

Reset_Settle_Time: Reset external timer

Settle_Time: Settling time in seconds

Copyright © Siemens AG 2015 All rights reserved

3.7 Operator / instruction texts

< If required – if operator/information texts are to be implemented >

Table 3-6

Number	Text

3.8 Position texts

Table 3-7

Number	Text
1	Idle
100	Start
101	Reset
102	Check_Vessel
103	Open Route
104	Error
201	Enable_Control_Strategy
202	Start_Timer
301	Pump_On
401	Pump_Off
402	Close_Valve
403	Stop_Timer
404	Enable_Manual
405	Disable_Manual
501	CMs_Off
502	Aborted
503	Completed

Copyright © Siemens AG 2015 All rights reserved

3.9 Connections

Table 3-8

I/O name	Data type	Comments
IN_CSEnableIDLE	DWord	*<optional>*
IN_CSEnableCS1	DWord	*<optional>*
IN_CSEnableCS2	DWord	*<optional>*
IN_CSEnableCS3	DWord	*<optional>*

Legend

CSEnableIDLE: Specifies to which control strategies can be changed from IDLE f

CSEnableCS1: Specifies to which control strategies can be changed from control strategy 1

3.10 Standard SFC type messages

Table 3-9

Nummer	Art	Text
SIG_1	Fault	Step execution time exceeded
NSIG_1	General operator prompt	Operator Prompt
NSIG_2	Status message – AS	Run
NSIG_3	Status message – AS	Completed
NSIG_4	Status message – AS	Held
NSIG_5	Status message – AS	Aborted
NSIG_6	Status message – AS	Ready to complete
NSIG_7	Status message – AS	Stopped
NSIG_8	As process control message - error	Error
NSIG_9	Status message – AS	Manual
NSIG_10	Status message – AS	Not released for SIMATIC BATCH
NSIG_11	Status message – AS	Execution time exceeded

Copyright © Siemens AG 2015 All rights reserved

3.11 Individual messages

Table 3-10

Number	Type	Text
SIG_2	Alarm high	Interlock failure
SIG_3	Alarm high	Tank Empty
SIG_4		
SIG_5		
SIG_6		
SIG_7		
SIG_8		
NSIG_12	Status message – AS	
NSIG_13	Status message – AS	
NSIG_14	Status message – AS	
NSIG_15	Status message – AS	
NSIG_16	Status message – AS	

Copyright © Siemens AG 2015 All rights reserved

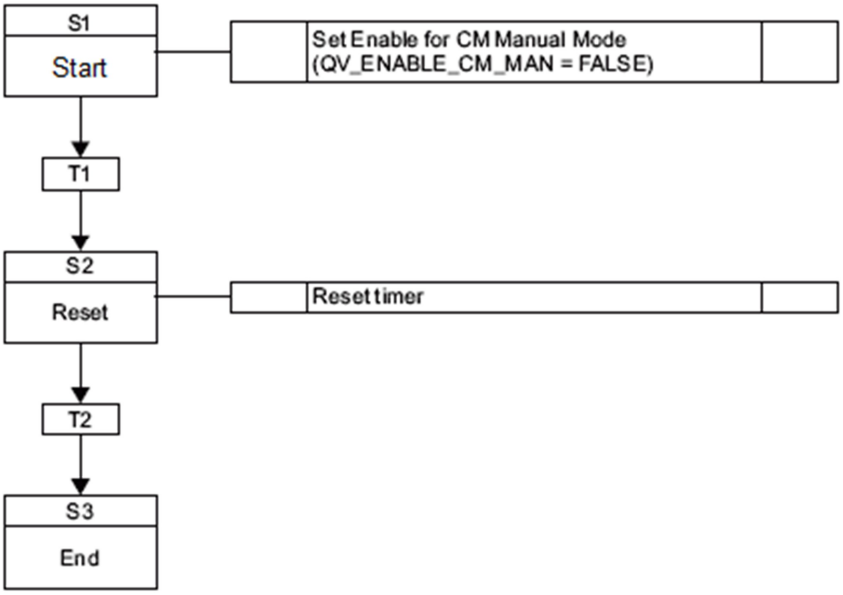
4 Control strategy 1 – „Discharge“

Operating status: „Starting“

In the start step, the enable for manual operation of the CMs and the enable for an active control strategy change are reset (ENASTART = FALSE).

In the starting state, the EM is initialized and all timers are reset.

Figure 4-1



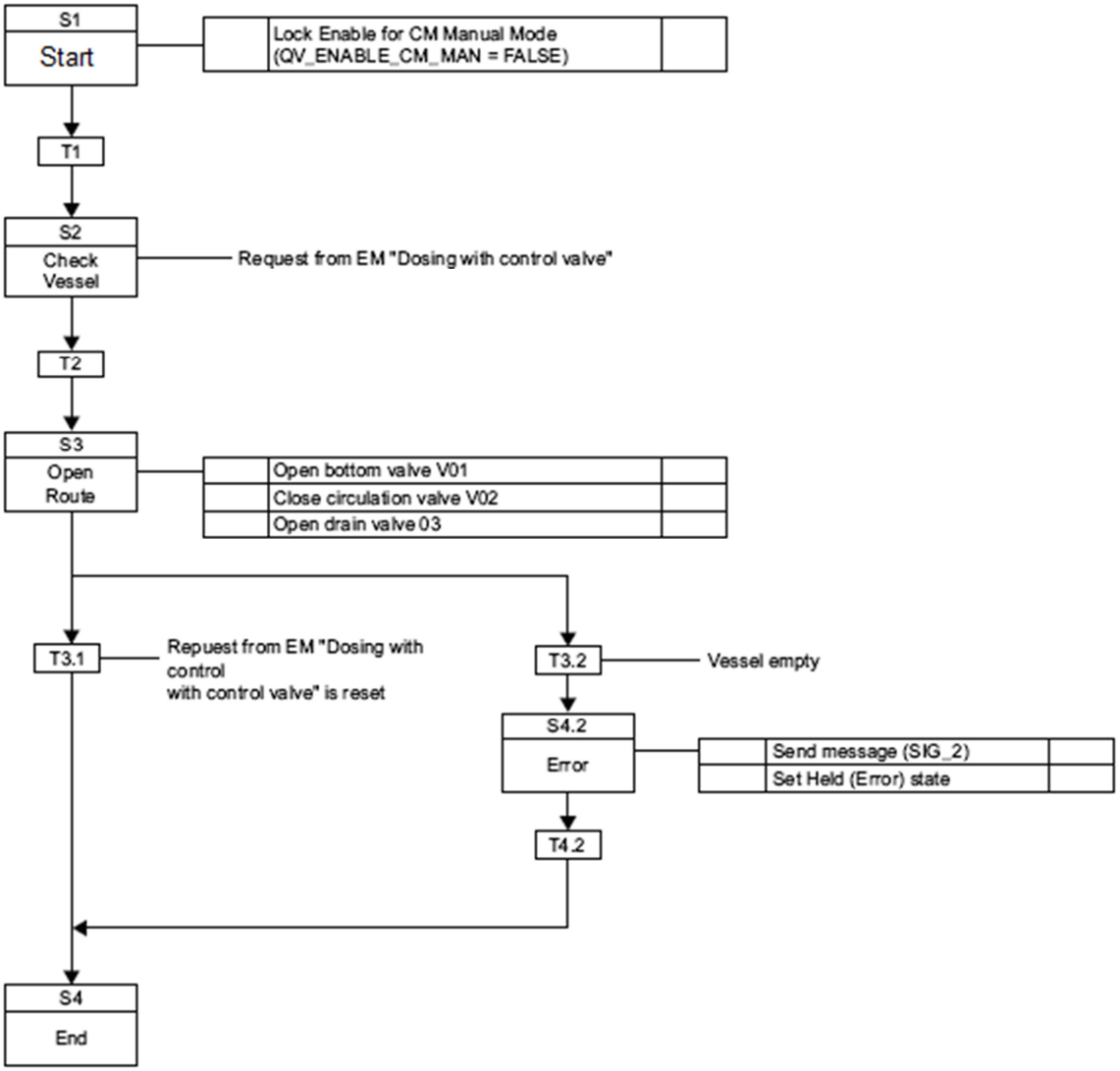
Operating status: „Run“

In the run state, the EM waits for the request of the dosing with control valve EM (PV_TANK_NO_OK = TRUE). If the request is set, the circulation valve V02 is closed, the bottom valve V01 and the drain valve V03 are opened. When pump valve V02 is closed and bottom drain valve V01 and drain valve V03 are open, the discharge is active. The sequence runs until the request of the Dosing with control valve EM is reset (PV_TANK_NO_OK = FALSE).

Copyright © Siemens AG 2015 All rights reserved

If the vessel is empty before the request is reset (PV_TANK_EMPTY = TRUE), the message SIG_2 is sent and the EM changes to the Error state.

Figure 4-2



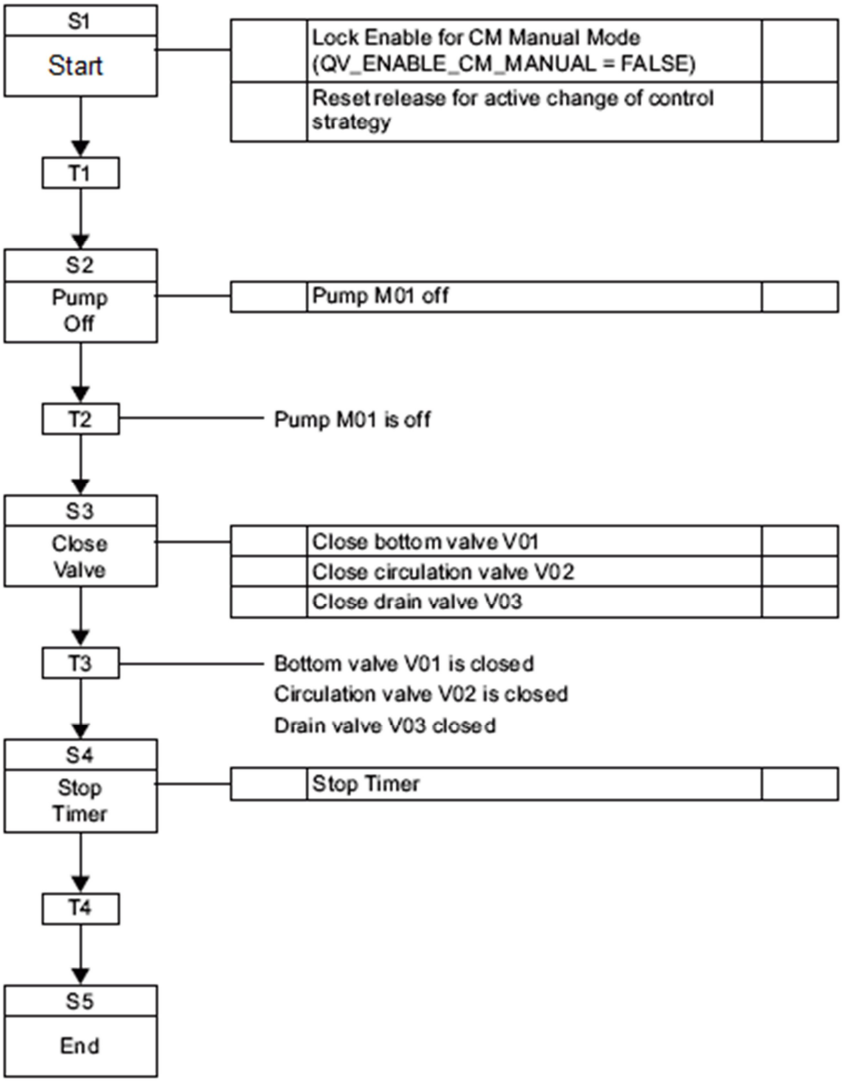
Copyright © Siemens AG 2015 All rights reserved

Operating status: „Completing“

In the start step, the enable for manual operation of the CMs and the enable for an active control strategy are reset (ENASTART = FALSE).

Pump M01 is turned off. Once the pump is off, all valves are closed. Following this the basic state (idle) is set via the completed state.

Figure 4-3



Copyright © Siemens AG 2015 All rights reserved

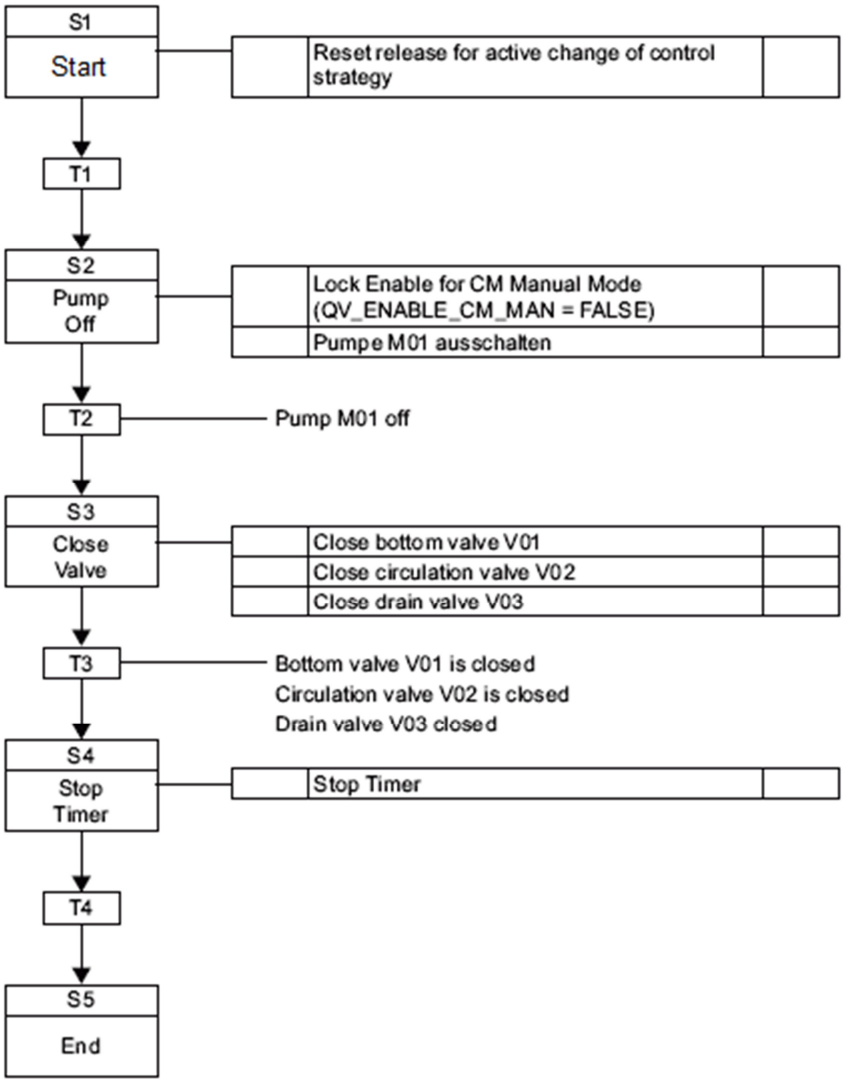
Operating status: „Holding“

In the start step, the enable for manual operation of the CMs and enable for an active control strategy are reset (ENASTART = FALSE).

In the holding state, pump M01 is turned off. Once the pump is off, all valves are closed. Once all the valves are closed, all timers are stopped.

The held state is achieved via the holding state.

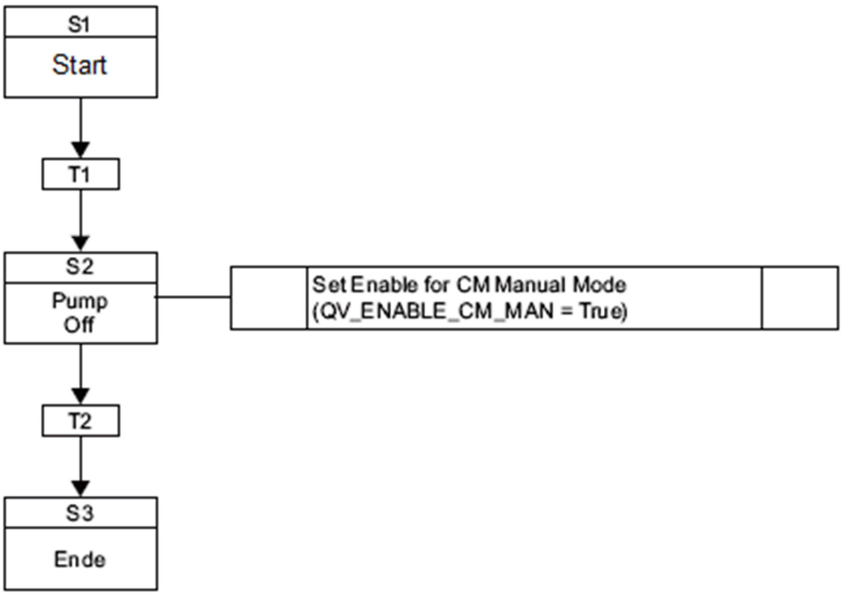
Figure 4-4



Copyright © Siemens AG 2015 All rights reserved

Operating status: „Held“

Figure 4-5



Operating status: „Error“

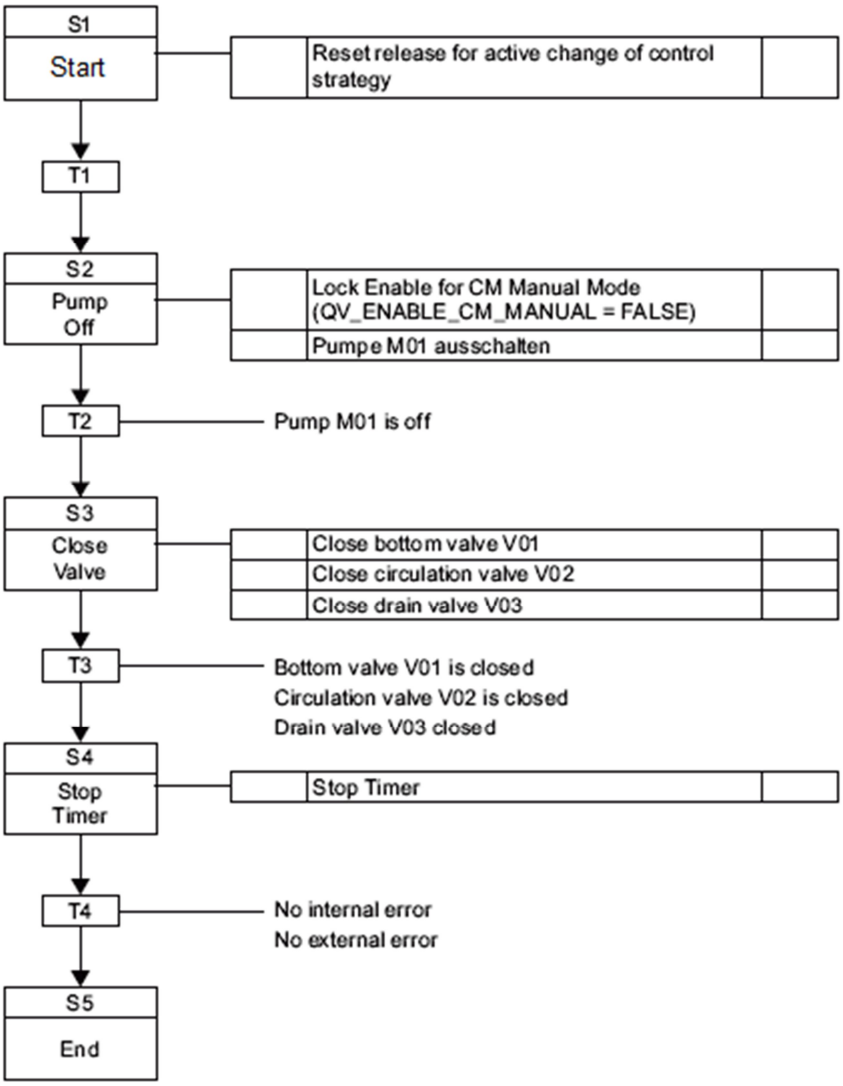
The error state is activated due to an external event (interlock) or due to an internal “Error” command.

In the start step, the enable for manual operation of the CMs is reset. (ENASTART = FALSE).

Copyright © Siemens AG 2015 All rights reserved

In the holding (error) state, the pump M01 is turned off. Once the pump is off, all valves are closed. Once all the valves are closed, all timers are stopped. If the error is no longer pending, the held (error) state is set after the holding (error) state.

Figure 4-6



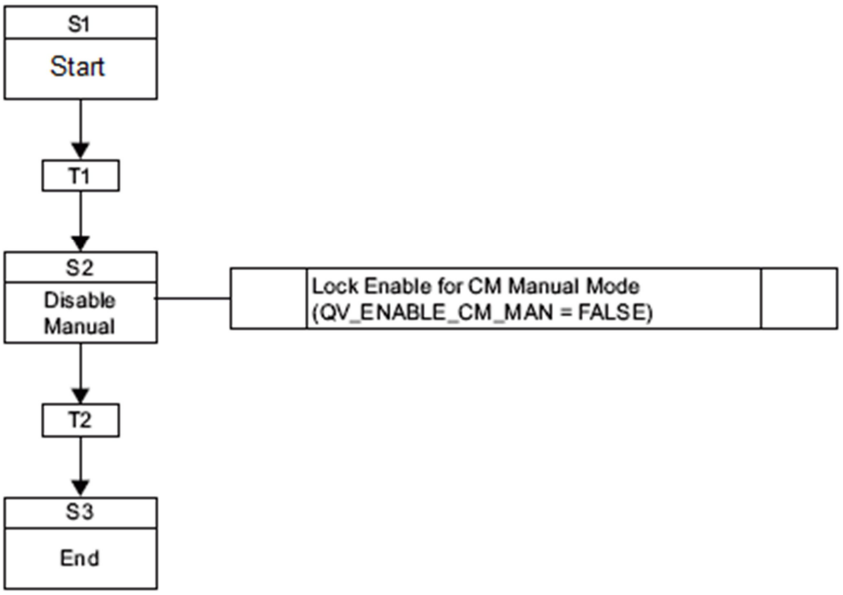
Copyright © Siemens AG 2015 All rights reserved

Operating status: „Resuming“

In the step „Disable Manual“ the enable for manual operation of the CMs is reset.

The run state is set again after the resuming state. The run sequence starts again from the Start step.

Figure 4-7



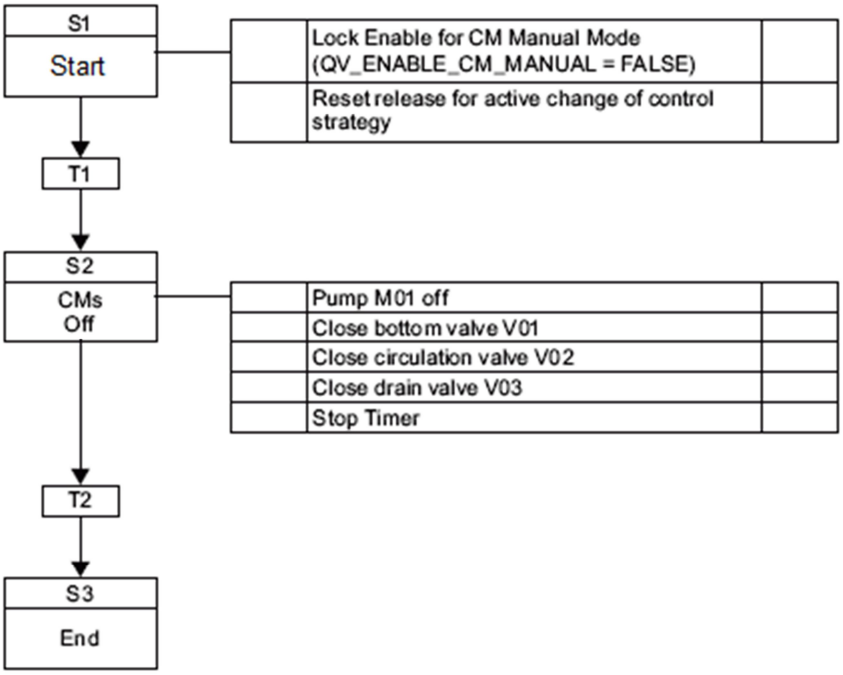
Copyright © Siemens AG 2015 All rights reserved

Operating status: „Aborting“

In the start step, the enable for manual operation of the CMs and enable for an active change of the control strategy are reset (ENASTART = FALSE).

In the state aborting, the pump M01 is turned off, the valves are closed and timers stopped. The idle state is set via the aborting state.

Figure 4-8



Copyright © Siemens AG 2015 All rights reserved

5 Control strategy 2 – „Drain“

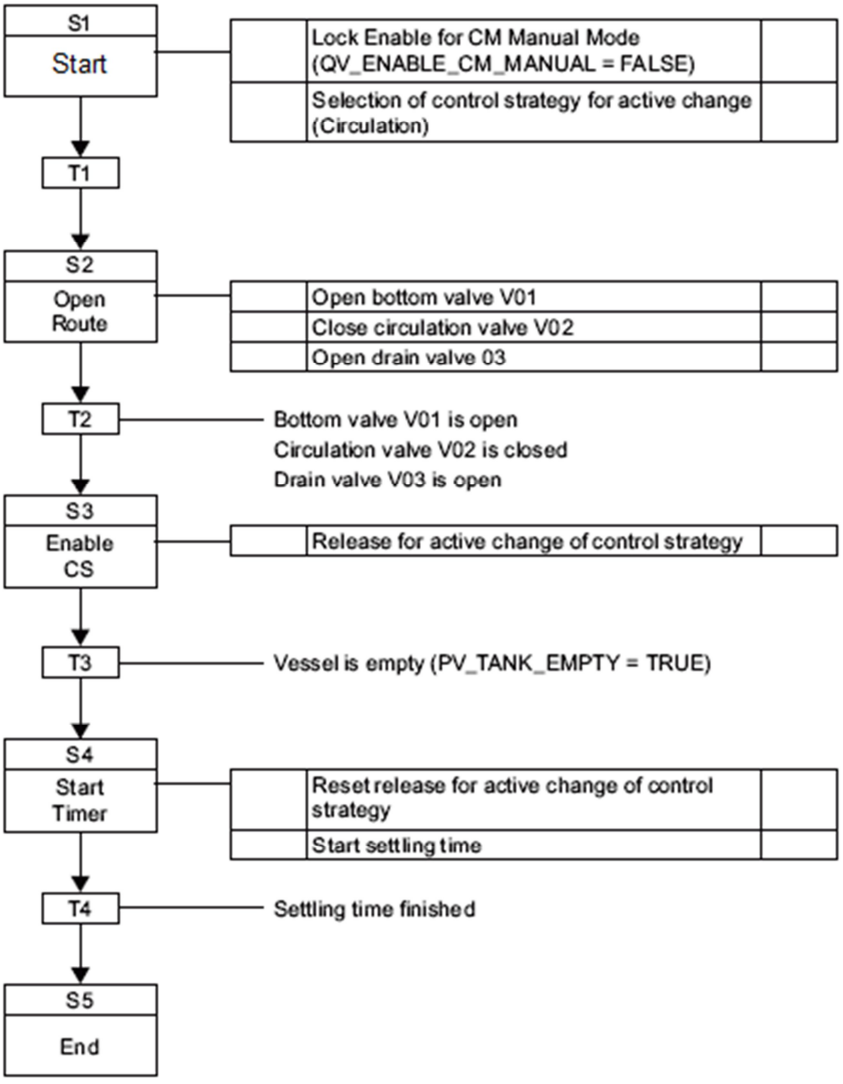
Operating status: „Run“

In the run state, the circulation valve V02 is closed, the bottom drain valve V01 and the drain valve V03 are opened. If the circulation valve V02 is closed, the bottom valve V01 and the drain valve V03 are open. The pump M01 is turned on.

If the vessel is empty, (PV_TANK_EMPTY = TRUE), the settling time (Settling_Time) is started to empty the vessel completely.

If the control strategy is not changed, the control strategy is terminated after the vessel has been fully emptied. A change to the circulation control strategy is possible.

Figure 5-1



NOTE The other step sequences for the Starting, Completed, Holding, … states correspond to the step sequences of control strategy 1 as described in Table 2-1

Copyright © Siemens AG 2015 All rights reserved

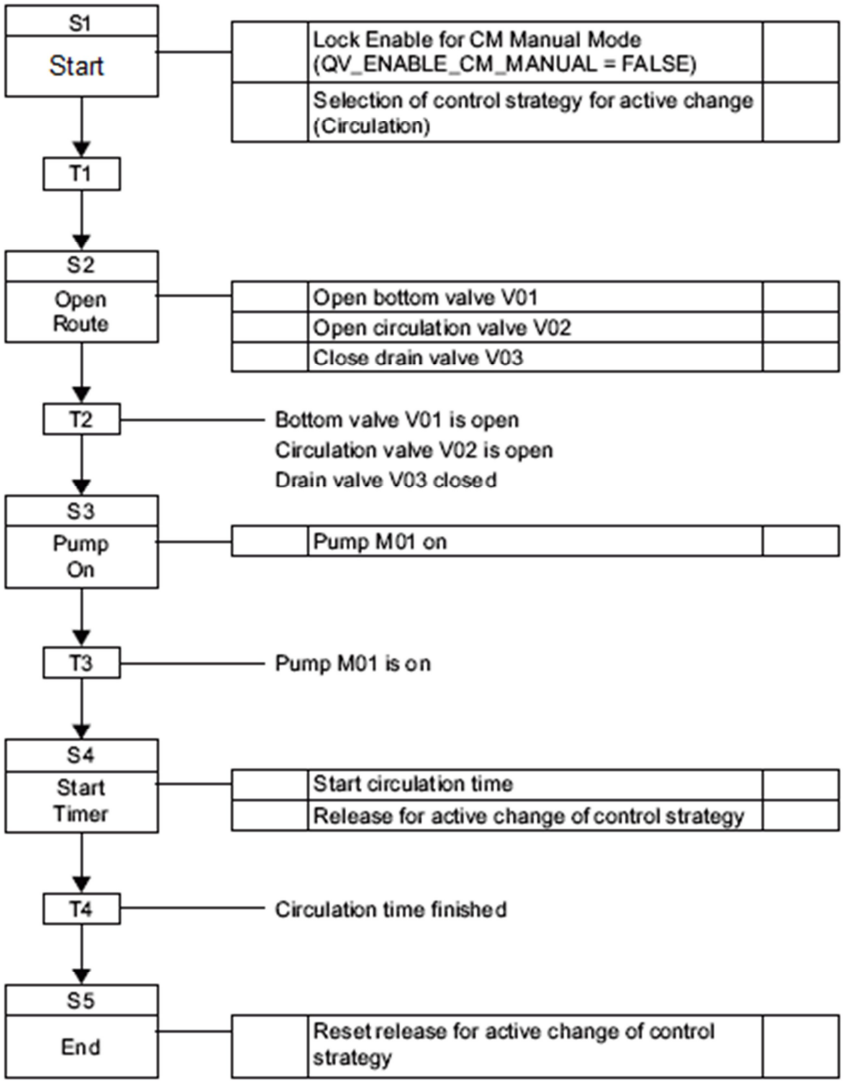
6 Control strategy 3 – „Circulation“

Operating status: „Run“

In the run state, the circulation valve V02 and the bottom valve V01 are opened, the drain valve V03 is closed. If V01 and V02 are open and V03 closed, the pump M01 is started. If the pump is on, the circulation time is started. On expiry of the circulation time, the bottom drain valve V01 is closed and the control strategy completed.

It is possible to change to the discharge or to the drain control strategy.

Figure 6-1



NOTE The other step sequences for the Starting, Completed, Holding, … states correspond to the step sequences of control strategy 1 as described in Table 2-1

Copyright © Siemens AG 2015 All rights reserved

7 Related literature

Table 7-1

	Topic	Title / Link
\1\	Siemens Industry Online Support	http://support.industry.siemens.com
\2\	Download page of this entry	https://support.industry.siemens.com/cs/ww/en/view/33412955
\3\	SIMATIC Process Control System PCS 7 Compendium Part C – Equipment Phases with SFC Types (V8.1)	https://support.industry.siemens.com/cs/ww/en/view/109098121
\4\	SIMATIC Process Control System PCS 7 SFC for SIMATIC S7 (V8.1)	https://support.industry.siemens.com/cs/ww/en/view/90663402

Copyright © Siemens AG 2015 All rights reserved

8 History

Table 8-1

Version	Date	Modifications
V1.0	04/2009	First version
V2.0	08/2012	Update Design & PCS 7 V8.0
V3.0	10/2015	Update Design & PCS 7 V8.1