

Specification of the technical function „Temperature“

SIMATIC PCS 7

Functional specification • August 2012

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1 Introduction

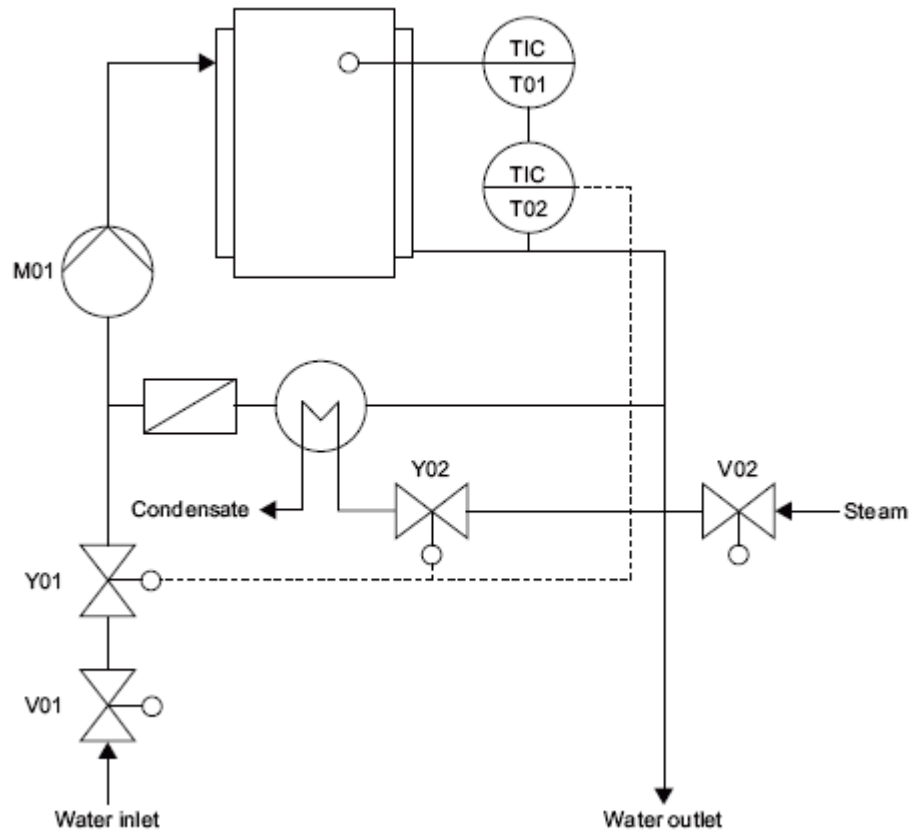
1.1 Terminology

Table 1-1

Term / Abbreviation	Description
CM	Control Module
CTRL_PID	Software block for PID 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



1.3 CM configuration

Table 1-2

Name	I/O name	CM	Description	Optional
M01	M01	MOTOR	Pump	
V01	V01	VALVE	Inlet valve	
V02	V02	VALVE	Heating steam valve	
T01	T01	CTRL_PID	Primary temperature controller	
T02	T02	CTRL_PID	Secondary temperature controller	

2 Execution behavior

In chemical processes a time-dependent temperature control of the product vessel is required. Therefore the equipment must ensure fast heat input or heat removal. To achieve this, a pressurized water circulation system is used in which a pump circulates the water in the jacket system.

The cooling water is heated indirectly by a heat exchanger. The required temperature is controlled by the steam pressure with a steam inlet control valve. The condensate is removed over a steam trap.

The temperature is controlled by a cascade control. The reference variable for the master (primary) controller is the internal temperature of the vessel and controls the valves for steam and cooling water. The follower (secondary) controller is designed as a split-range controller. The control valves are therefore not controlled by the EM. They operate in the "set externally" mode.

The cascade control is open depending on the level of the vessel. This means that if the tank level no longer ensures that the temperature sensors are immersed in the product, the controller outputs generated from the internal temperature in the master controller are no longer used as a setpoint for the slave controller, but a switchover to direct setpoint input from the EM is performed.

General

The CMs are checked on status failure-free.

Hold conditions (LOCKERROR):

- CM in fault/error state

Summary of the states

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

Table 2-1

State	Control Strategy 1 Temperature_Control
Starting	X
Run	X
Completing	X
Ended	
Holding	X
Held	X
Holding error	X _{holding}
Held error	
Resuming	X
Resuming error	X _{resuming}
Stopping	X
Stopped	
Aborting	X
Aborted	

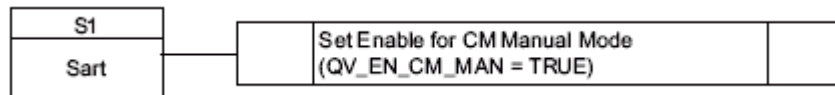
Legend

- X: Sequencer exists
- 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



3 Parameter description

3.1 Control strategies

Table 3-1

Number	Name
1	Temperature_Control

3.2 Setpoint (SP_)

Table 3-2

Control parameter	Unit	Setpoint change in status running	Control strategy											
			1	2	3	4	5	6	7	8	9	10		
Temperature (SP_TEMP)	°C		x											
Tolerance (SP_TOLERANCE)	°C		x											
Hold_Time (SP_HOLD_TIME)	min		x											

Legend

- Temperature: Setpoint temperature of the product in °C
- Tolerance: Time for which the product will be kept at the setpoint temperature
- Hold_Time: Time for which the product will be kept at the setpoint temperature

3.3 Process values (PV_xy)

Table 3-3

Name	Data type	Unit	I/O name
Level_Tank	Analog	l	PV_LEVEL_TANK
Neg_Tolerance	Analog	l	PV_NEG_TOL
Hold_Time_sec	Analog	sec	PV_HOLD_TIME_SEC

Legend	Level_Tank:	Actual vessel level in liters
	Neg_Tolerance:	Negative tolerance
	Hold_Time_sec:	Holding time in seconds

3.4 Parameters (IN_xy)

Table 3-4

Name	Data type	Unit	I/O name
Min_Level_Tank	Analog	l	IN_MIN_LEVEL_TANK
Settle_Time_TR	Analog	sec	IN_TR_SETL
Settle_Time_TJ	Analog	sec	IN_TJ_SETL

Legend	Min_Level_Tank:	Minimum vessel level in liters
	Settle_Time_TR:	Time in which the temperature of the product must settle in to the setpoint temperature (T01)
	Settle_Time_TJ:	Time in which the temperature of the product must settle in to the setpoint temperature (T02)

3.5 Timers (TI_x)

Table 3-5

Name	I/O name
TI_Settle_Time_TR	TI_TR_SETL
TI_Settle_Time_TJ	TI_TJ_SETL
TI_Hold_Timer	TI_HOLD_TIMER

Legend

TI_Settle_Time_TR: Timers for controlling the settle time for inner temperature control

TI_Settle_Time_TJ: Timers for controlling the settle time for jacket temperature control

TI_Hold_Timer: Timer for controlling the holding time

3.6 Control values (QV_xy)

Table 3-6

Name	Data type	I/O name
Enable_CM_Manual	BOOL	QV_EN_CM_MAN
Control_Mode	BOOL	QV_CTRL_MODE

Legend

Enable_CM_Manual: Enables switchover to CM manual mode

Control_Mode: 0 = inner temperature, 1 = jacket temperature

3.7 Operator / instruction texts

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

Table 3-7

Number	Text

3.8 Position texts

Table 3-8

Number	Text
1	Idle
100	Start
102	Reset
103	Open_Valve
104	Pump_On
105	Ctrl_Inside_Temp_On
106	SettleTime_Inside_Temp
107	Ctrl_Jacket_Temp_On
108	SettleTime_Jacket_Temp
109	HoldTime_Temperature
110	Error
201	Control_Modules_Off
202	Stop_Timer
203	Enable_Manual
204	Disable_Manual
301	Temp_Ctrl_Off
302	Pump_Off
303	Close_Valve
304	Reset_Message
307	Aborted
308	Stopped
309	Completed

3.9 Standard SFC type messages

Table 3-9

Number	Type	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

Number	Type	Text
NSIG_11	Status message – AS	Execution time exceeded

3.10 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	

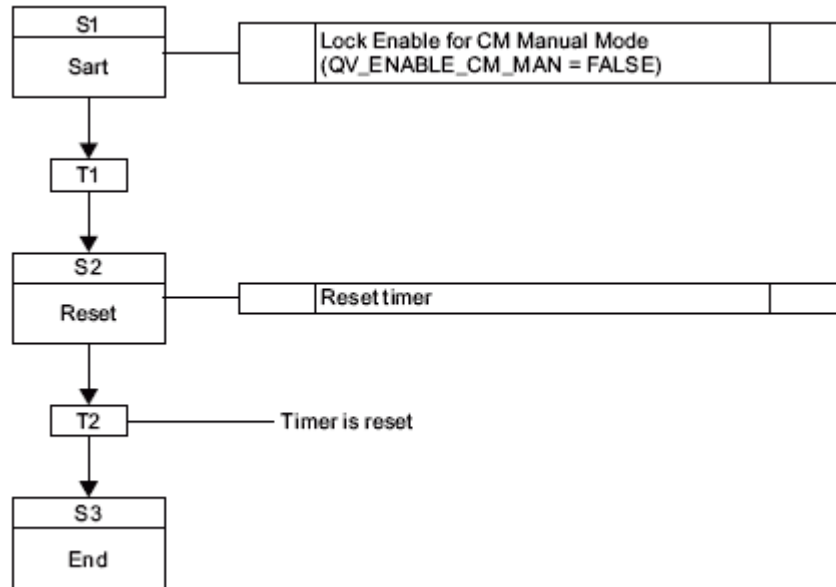
4 Control strategy1 – „Temperature_Control“

4.1 Operating status: „STARTING“

In the start step, the enable for manual operation of the CMs is reset.

In the starting state, the EM is initialized and in the rest state all times are reset.

Figure 4-1



4.2 Operating status: „RUN“

In the run state, the control loop is opened first.

In the run state, the inlet valve V01 and the heating steam valve V02 are opened. Once these are opened, the pump M01 is turned on.

Once pump M01 is turned on, the temperature control starts. Two cases must be distinguished for this case:

Case 1: Inner temperature control

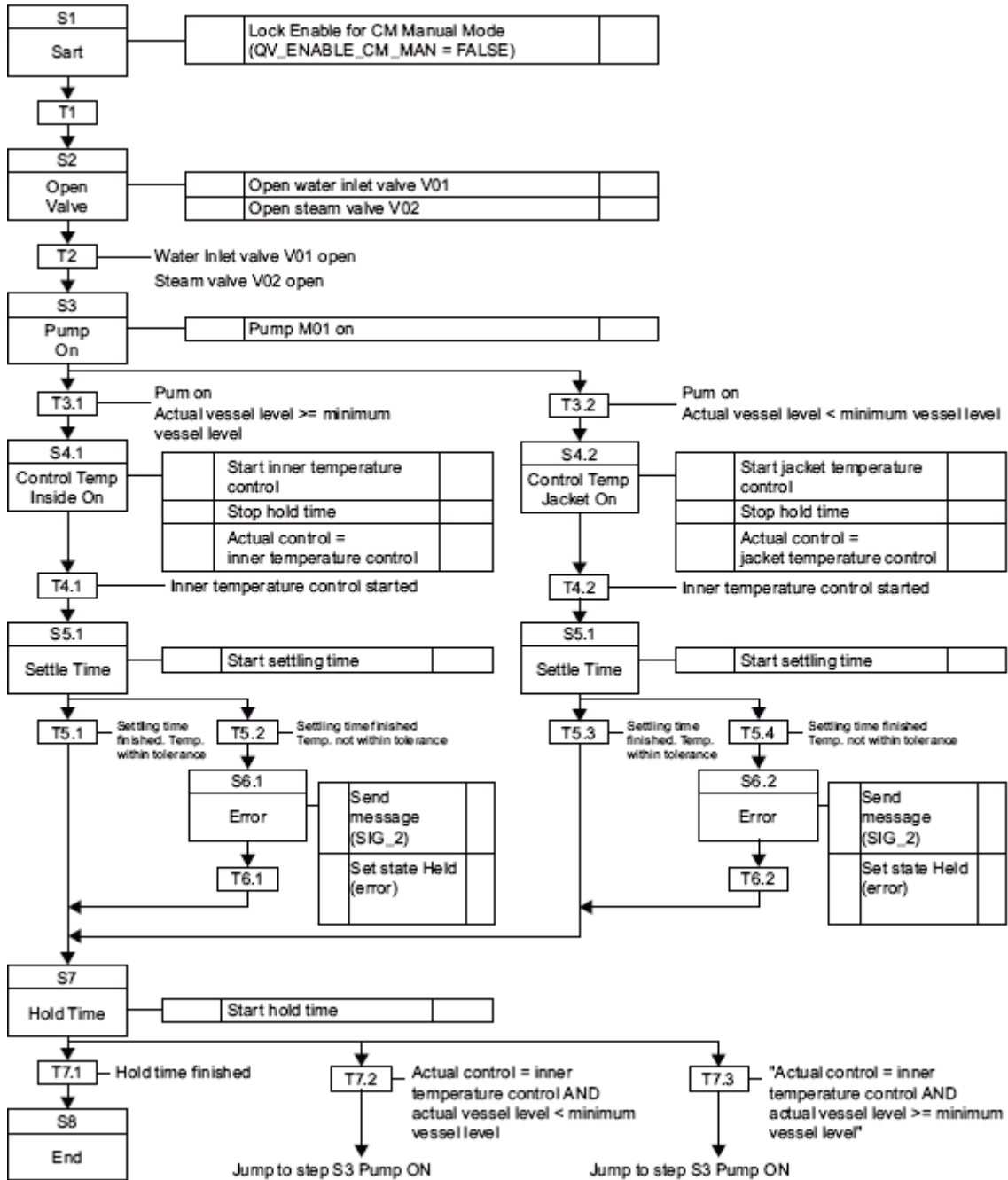
If the vessel level (PV_LEVEL_TANK) is above the minimum vessel level (IN_MIN_LEVEL_TANK), the temperature is controlled by the cascade control. The master controller receives the temperature setpoint (SP_TEMP) from the EM and propagates its manipulated variable to the setpoint of slave controller. If the inner temperature is within the set tolerance (SP_TOLERANCE) following the settling time for inner temperature control (TI_TR_SETL), the control strategy is terminated automatically after a holding time (TI_HOLD_TIMER). If the inner temperature is not within the tolerance, a message is sent and the EM changes to the held state.

If the vessel level falls below the minimum vessel level, the holding time is stopped and activity continues as described in **case 2**. Note that the stopped time from this case (**case 1**) continues in **case 2** and is not restarted.

Case 2: Jacket temperature control

If the vessel level (PV_LEVEL_TANK) is below the minimum vessel level (IN_MIN_LEVEL_TANK), the cascade control is open and only the jacket temperature is controlled by the slave temperature controller; in other words the temperature setpoint (SP_TEMP) is now connected directly to the slave temperature controller from the EM. If the jacket temperature is within the set tolerance (SP_TOLERANCE) following the settling time for jacket temperature control (TI_TJ_SETL), the EM is terminated automatically after a holding time (TI_HOLD_TIMER). If the Temperature is not within the set tolerance following the settling time, a message is sent and the EM changes to the held state. If the vessel level rises above the minimum vessel level, the holding time is stopped and activities continue as described in **case 1**. Note that the stopped holding time continues in **case 1** and is not restarted.

Figure 4-2



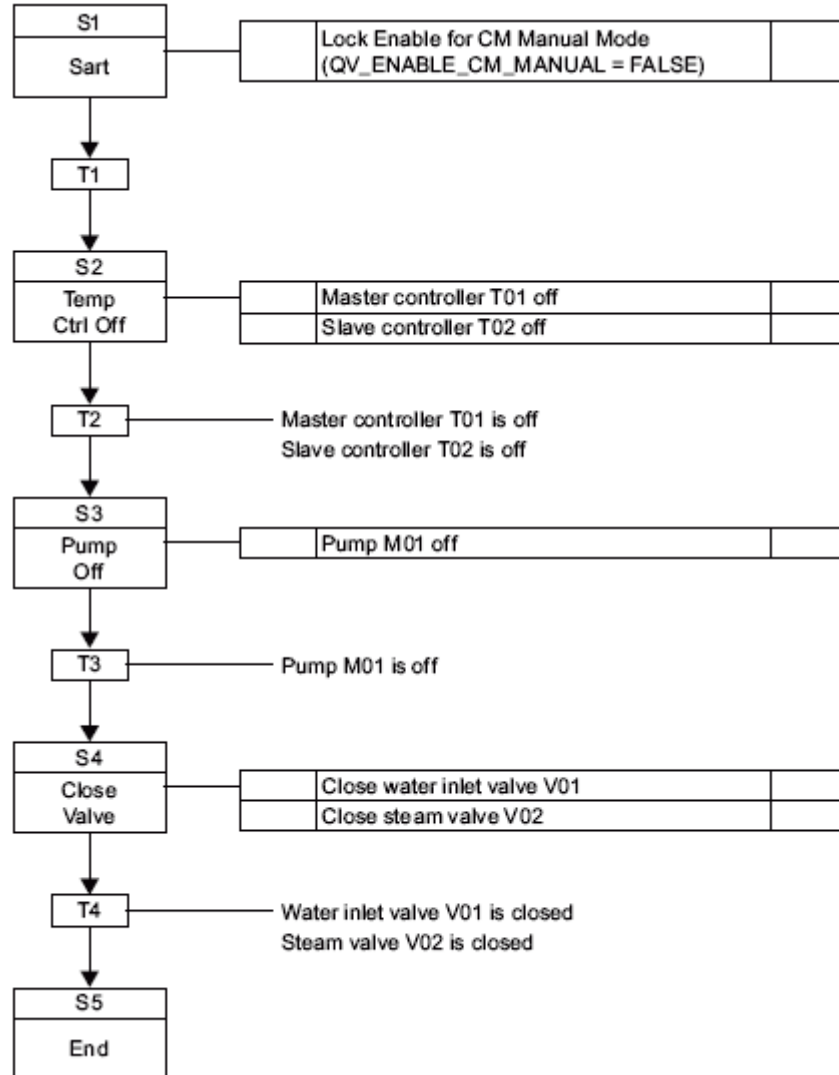
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4.3 Operating status: „COMPLETING“

In the start step, the enable for manual operation of the CMs is reset.

In the completing state, the master controller T01 and the slave controller are turned off first. Once the controllers are off, pump M01 is turned off. Finally the heating steam valve and the inlet valve are closed. Once these are closed, the idle state is set via the completed state.

Figure 4-3



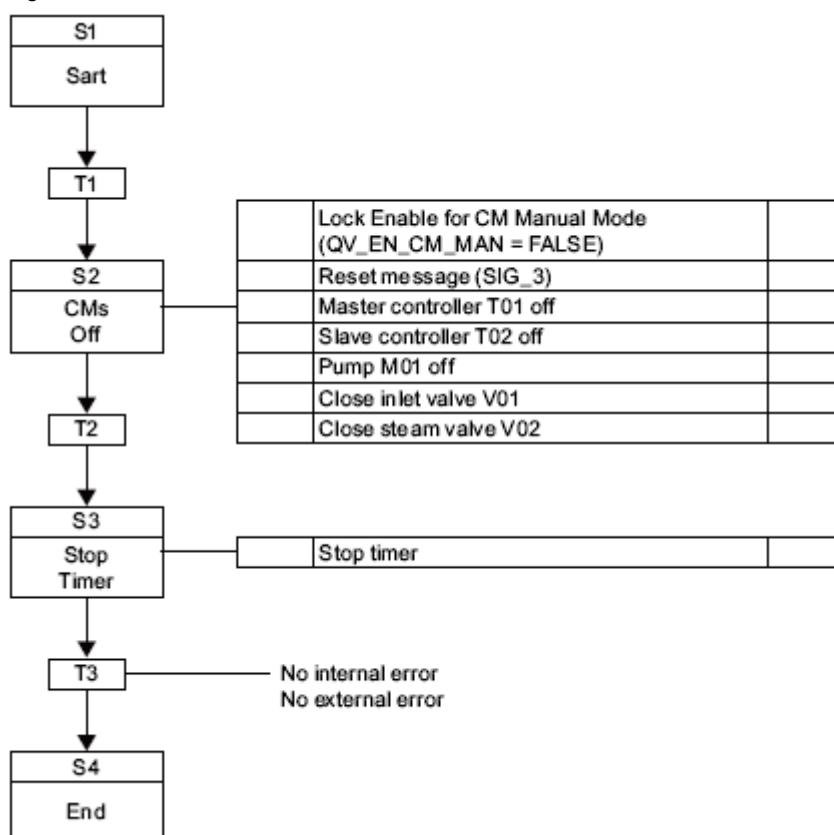
4.4 Operating status: „HOLDING“

In the “CMs Off” step, the enable for manual operation of the CMs and a pending message (SIG_3) of the EM are reset.

In the holding state, the master controller T01, the slave controller T02 and the pump M01 are turned off, the heating steam valve and the inlet valve are closed and all timers stopped.

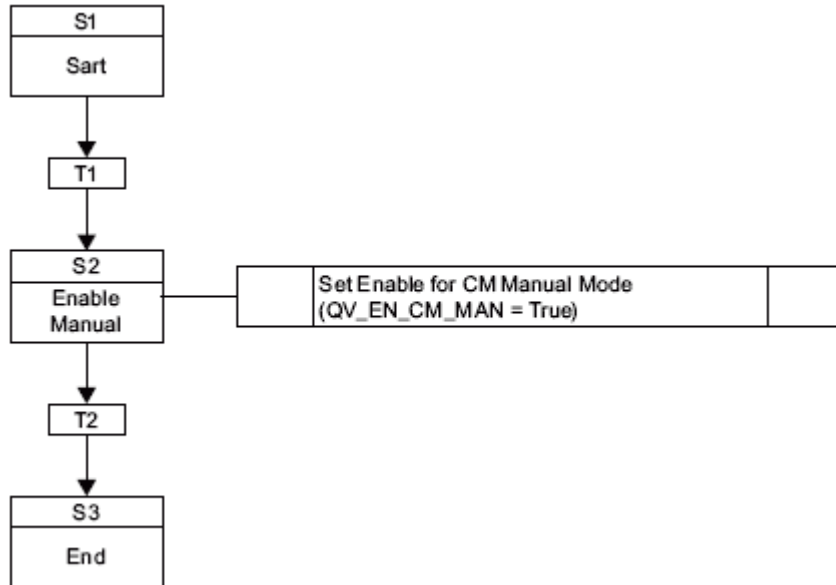
The held state is set via the holding state.

Figure 4-4



4.5 Operating status: „HELD“

Picture 4-5



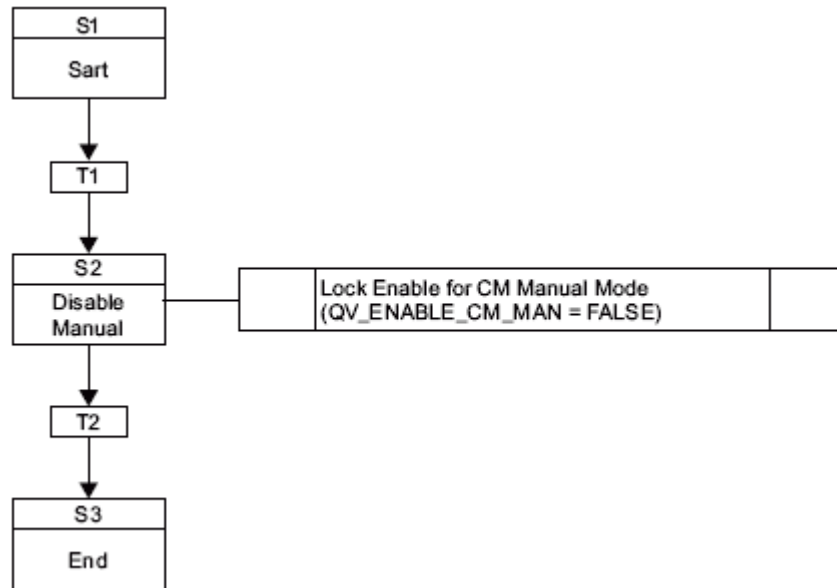
4.6 Operating status: „RESUMING“

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

In the resuming state, all timers are reset.

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

Figure 4-6



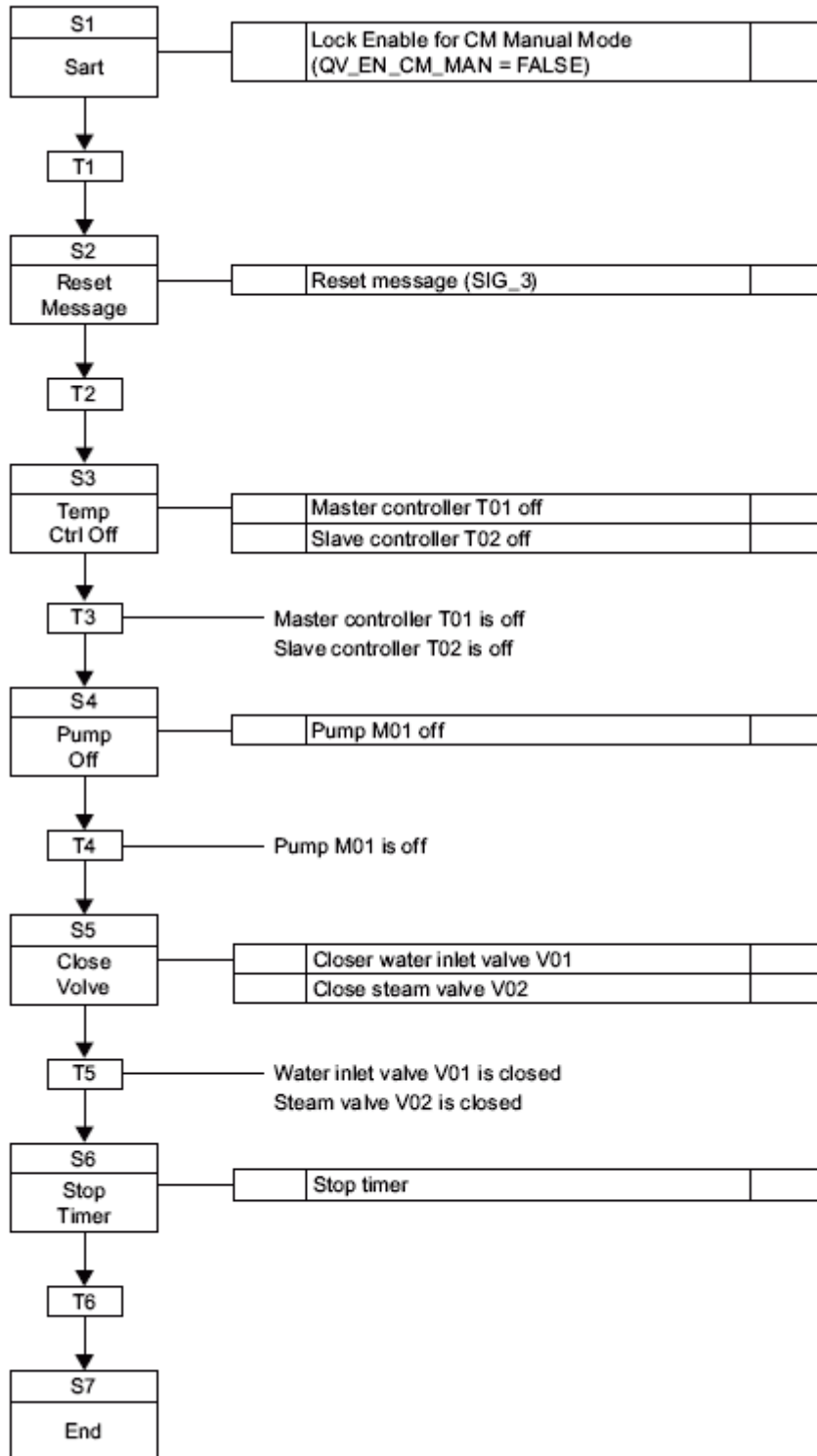
4.7 Operating status: „STOPPING“

In the start step, the enable for manual operation of the CMs is reset.

In the stopping state, the master controller T01 and the slave controller are turned off first. Once the controllers are off, pump M01 is turned off. Finally the heating steam valve V02 and the inlet valve V01 are closed. If they are closed, all timers are stopped.

The basic state (idle) is set via the stopping state.

Figure 4-7



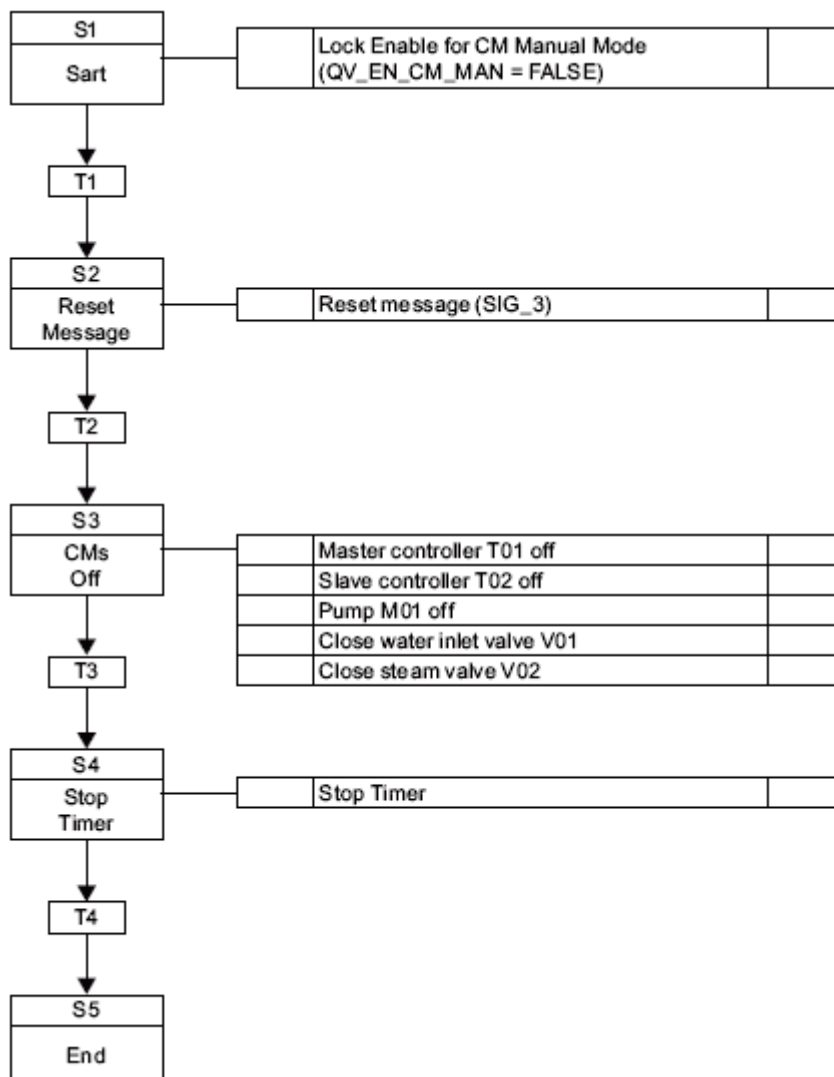
4.8 Operating status: „ABORTING“

In the start step, the enable for manual operation of the CMs is reset.

In the holding state, the master controller T01, the slave controller T02 and the pump M01 are turned off, the heating steam valve V02 and the inlet valve V01 are closed and all timers stopped.

The basic state (idle) is set via the aborting state.

Figure 4-8



5 History

Table 5-1

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