



KONGSBERG

# ***Functional Description***

## ***K-Chief 600 Control System***

***Yard:HHI & HSHI***

***Hull no.:H2714-6 & S737-8***

## Revisions

Rev.	Written by		Checked by		Approved by	
	Date	Sign.	Date	Sign.	Date	Sign.
A	2014-07-24	CMP	2014-08-10	SIC	2014-08-20	CMP
B	2014-09-11	SIC				
C						
D						

## Document history

Rev. A     First issue. Base on Yard's POS & IO list

The information contained in this document may be subject to change at a later date (due, for instance, to availability of components). Notice will be given only in case such a change is deemed to be of any consequence for customers. Kongsberg Maritime AS shall not be liable for incidental or consequential damages in connection with the furnishing, performance, or use of this document.

© 2014 Kongsberg Maritime AS. All rights reserved. No part of this work covered by the copyright hereon may be reproduced or otherwise copied without prior permission from Kongsberg Maritime AS.

### Kongsberg Maritime AS

Bekkajordet  
P.O.Box 1009  
N-3194 Horten,  
Norway

Telephone: +47 81 57 37 00  
Telefax: +47 85 02 80 28  
**[www.kongsberg.com](http://www.kongsberg.com)**



**KONGSBERG**

## Table of contents

<b>1</b>	<b>INTRODUCTION .....</b>	<b>7</b>
1.1	Basic philosophy .....	7
1.2	Sub-systems .....	7
<b>2</b>	<b>REMOTE CONTROL OF PUMPS, FANS AND OTHER EQUIPMENT .....</b>	<b>8</b>
2.1	Starter logic .....	8
2.1.1	Functions and options .....	8
2.1.2	Starter types .....	8
2.1.3	Parameters .....	9
2.1.4	Alarm and event enable .....	9
2.1.5	Standard alarms .....	9
2.1.6	Auto mode .....	9
2.1.7	Restart after blackout.....	9
2.1.8	Shutdown and start block .....	9
2.1.9	Single acting control.....	10
2.1.10	Power fail when blackout .....	10
2.1.11	Signals required for the different pumps .....	10
2.1.12	Pump, and Fan control used for this project.....	12
2.2	Stand-by pumps .....	14
2.2.1	Stand-by controller .....	14
2.2.2	Functions and options .....	14
2.2.3	Auto and manual.....	15
2.2.4	Stand-by priority.....	15
2.2.5	Automatic stop of the failed master.....	15
2.2.6	Stop master choices .....	15
2.2.7	Stand-by controller timers .....	15
2.2.8	Stand-by start.....	16
2.2.9	Manual operation.....	16
2.3	Pump control used for this project.....	17
<b>3</b>	<b>COMPRESSED AIR SYSTEMS .....</b>	<b>19</b>
3.1	Compressor controller .....	19

3.1.1	Compressor controller sub-types .....	19
3.1.2	Pressure signal .....	19
3.1.3	Functions and options .....	20
3.1.4	Auto and not auto .....	20
3.1.5	Sub-modes when in auto mode.....	20
3.1.6	Priority .....	20
3.1.7	Safety.....	21
3.2	Compressor controller parameters.....	21
3.3	The compressor start/stop conditions .....	22
3.4	Compressor control used for this project.....	28
<b>4</b>	<b>VALVE CONTROL.....</b>	<b>29</b>
4.1	Position controller .....	29
4.1.1	Functions and options .....	29
4.1.2	Positioning types .....	29
4.1.3	Type of operation .....	31
4.2	Valve control used for this project .....	34
<b>5</b>	<b>ENGINEER SAFETY SYSTEM .....</b>	<b>37</b>
<b>6</b>	<b>BALLAST AND FUEL TANK MONITORING.....</b>	<b>38</b>
6.1	Level measurement by pressure transmitters.....	38
6.2	Conversion from level to volume .....	38
6.3	Interface to load calculator .....	40
<b>7</b>	<b>BALLAST WATER TREATMENT SYSTEM.....</b>	<b>41</b>
7.1	Interface to ballast water treatment system .....	41
7.2	Valves control for Ballast water treatment. ....	41
7.2.1	Valve control position. ....	41
7.2.2	Valves control request and feedback signals. ....	41
7.2.3	Valves status to BWTS.....	42
7.3	BWTS on K-Chief 600 system.....	43
<b>8</b>	<b>PUMP AUTO CONTROL .....</b>	<b>44</b>
8.1	H.F.O Transfer pump .....	44
8.1.1	HFO transfer pump Auto Start/Stop.....	44
8.2	M.G.O Transfer pump .....	45

8.2.1	MGO transfer pump Auto Stop .....	45
8.3	Oily bilge pump .....	46
8.3.1	Oily bilge pump Auto Start/Stop .....	46
8.4	Sludge pump .....	46
8.4.1	Sludge pump Auto Stop .....	46

## **Terms and abbreviations**

DPU	Distributed Processing Unit
HFO	Heavy Fuel Oil
I/O	Input/Output
BWTS	Ballast Water treatment system
A/C	Air Condition
ESS	Engergy Saving System

# **1 INTRODUCTION**

## **1.1 Basic philosophy**

This document describes the Kongsberg Maritime Distributed Process Control System.

The information in this document will provide a clear understanding of the Distributed Process System, including basic operation and features.

The system is designed to control all the required equipment in the Engine Room and for the Cargo area. This includes the control of motors, pumps, valves and fans.

The control features required for the equipment are dependent on which functions the equipment will cover as a part of a dedicated sub-system.

The equipment may be operated manually from operator input using mimic displays or automatically by the control logic, as a result of measurements and commands or initiated by other sub-systems.

## **1.2 Sub-systems**

The following sub-systems are described:

- Remote control of pumps, fans and other equipment
- Compressed air systems
- Valve control
- Engineer safety system
- Ballast and fuel tank monitoring
- Ballast treatment system

## 2 REMOTE CONTROL OF PUMPS, FANS AND OTHER EQUIPMENT

### 2.1 Starter logic

Starter logic for electrical motors is operated directly from the Operator Station or from other control logic within the DPUs, i.e. by a stand-by pump controller.

#### 2.1.1 Functions and options

The following functions and features are available:

- Start and stop sequence for two speeds and two different directions
- Alarm reporting for start- and stop-failure
- Alarm reporting for tripping or started without being commanded
- Auto and semi auto mode (manual) control
- Automatic time delayed restart when recovering from blackout
- Blocking from operation for “Local switch” operation or after blackout
- Automatic shut down
- Optional timestamp on every change of operation, i.e. recording time of starting, running and stopping

#### 2.1.2 Starter types

The starter logic can operate the following types of starters:

Sub-type	Name	Description
1	Single speed	One speed control in one direction
2	Two speed	Two speed in the same direction
3	Two directional	One speed in two directions
4	All speed	Two speed in two directions
5	Single acting	One speed with steady relay control



### **2.1.3 Parameters**

- Timeout: Timeout for start and stop commands
- Wait change direction: Wait time when changing direction of speed
- Pulse on: Pulse duration during start and stop command
- Blackout restart time: Time from recovered from blackout until the unit is restarted after blackout
- Stopped time: Stand still time when changing speed with stop pulse

### **2.1.4 Alarm and event enable**

Parameters for enabling and disabling alarms and events are available. Some alarms shall be enabled at any time, due to requirement by classification society. Start fail alarm and trip alarm are among these.

### **2.1.5 Standard alarms**

The following conditions will result in an alarm, and the starter will be set to manual:

- Trip
- Start fail
- Stop fail
- Started without being commanded

### **2.1.6 Auto mode**

The starter can be operated in two different modes; auto and semi auto. A unit can be automatically started and stopped. In semi auto only manual start and stop is possible, except for shutdown.

### **2.1.7 Restart after blackout**

Restart after blackout applies to both auto and manual mode. The function is activated when the timer is set larger than zero, and the blackout detector is referred to by the tag reference.

### **2.1.8 Shutdown and start block**

The shut down / start block function is active both in auto and manual mode.

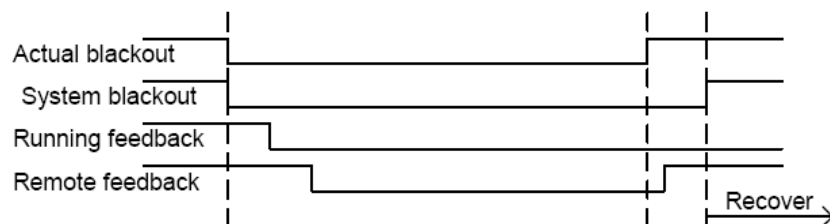
### 2.1.9 Single acting control

One relay is used for start and stop of the controlled unit. The relay will be steady on as long as the unit is meant to be running, and de-activated when the unit is meant not to be running. This functionality applies to running low speed forward only.

If no running feedback is defined for single acting control, the starter will generate the running feedback internally, based on the control performed. In this way the events sent from the starter would include the correct running information.

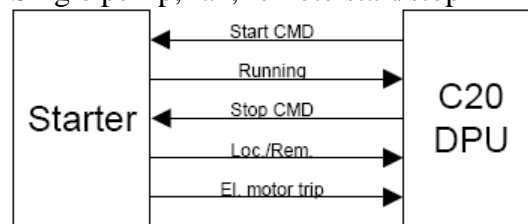
### 2.1.10 Power fail when blackout

Some starters have the local remote switch in serial connection with the power failure switch in the starter. At blackout, the starter controller will lose the remote signal. It is important that the starter controller detects the blackout before it is set to local, and that the remote signal is back before the starter controller receives recover from blackout. Entering a delay off at the running and remote feedback, and a delay on at the system blackout signal is a solution.

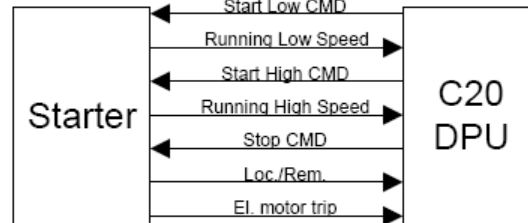


### 2.1.11 Signals required for the different pumps

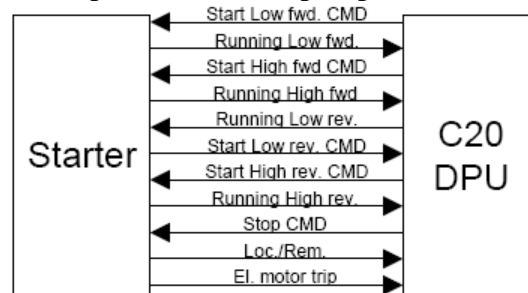
Single pump, fan, remote start/stop



### Two speed pump, fan start/stop



### Two speed, reversible pump, fan start/stop



### Sequence controller

The sequence controller operates up to ten tags in a sequence. The tags are operated with adjustable time delays and commands. Typically usage is group start and stop. One tag can be listed more than once.

#### Features

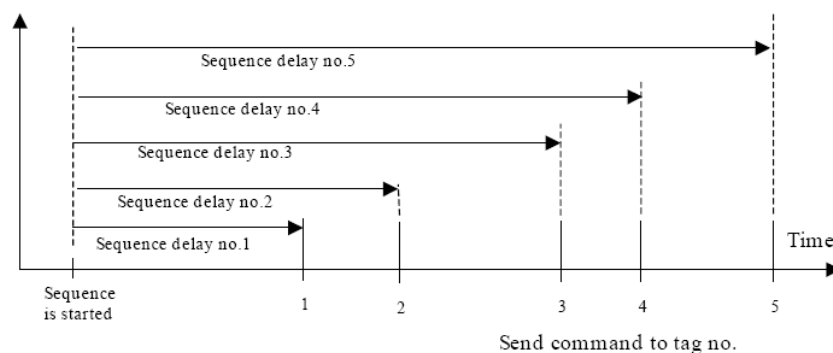
- Sends individual commands like start, stop, reset, auto etc. to a number of tags
- Adjustable sequence delays

#### Auto and enabled

The auto pump controller has no auto or semi-auto mode.

#### Details

Single pumps are commanded directly. Pumps in a stand-by system are controlled via the belonging stand-by control unit. The sequence controller will send a group start command to the stand-by controller, and then this will start the pump with highest priority.



## 2.1.12 Pump, and Fan control used for this project

### Single pump

There are (23) pumps controlled by this system.

PP006_P	G/E MGO SUPPLY PP	XC	Starter - Pump 1-way 1-speed
PP023_P	NO.1 A/C COND CFW BOOST PP	XC	Starter - Pump 1-way 1-speed
PP024_P	NO.2 A/C COND CFW BOOST PP	XC	Starter - Pump 1-way 1-speed
PP025_P	PROV REF COND CFW BOOST PP	XC	Starter - Pump 1-way 1-speed
PP027_P	EMCY FIRE PP	XC	Starter - Pump 1-way 1-speed
PP028_P	NO.1 MAIN CSW PP	XC	Starter - Pump 1-way 1-speed
PP029_P	NO.2 MAIN CSW PP	XC	Starter - Pump 1-way 1-speed
PP030_P	NO.3 MAIN CSW PP	XC	Starter - Pump 1-way 1-speed
PP031_P	M/E CYL. OIL SHIFT PP	XC	Starter - Pump 1-way 1-speed
PP032_P	NO.1 BILGE/FIRE G/S PP	XC	Starter - Pump 1-way 1-speed
PP033_P	NO.2 BILGE/FIRE G/S PP	XC	Starter - Pump 1-way 1-speed
PP034_P	NO.1 BALLAST PP	XC	Starter - Pump 1-way 1-speed
PP035_P	NO.2 BALLAST PP	XC	Starter - Pump 1-way 1-speed
PP036_P	H.F.O TRANSFER PP	XC	Starter - Pump 1-way 1-speed
PP037_P	L.O TRANSFER PP	XC	Starter - Pump 1-way 1-speed
PP038_P	SLUDGE PP	XC	Starter - Pump 1-way 1-speed
PP039_P	M.G.O TRANSFER PP	XC	Starter - Pump 1-way 1-speed
PP040_P	OILY BILGE PP	XC	Starter - Pump 1-way 1-speed
PP041_P	BILGE CIRC. PP	XC	Starter - Pump 1-way 1-speed
PP042_P	NO.1 F.W PP FOR HYD UNIT	XC	Starter - Pump 1-way 1-speed
PP043_P	NO.2 F.W PP FOR HYD UNIT	XC	Starter - Pump 1-way 1-speed
PP044_P	F.W GEN. EJECTOR PP	XC	Starter - Pump 1-way 1-speed
PP045_P	HP&LP CIRC PP COOL BOOST PP	XC	Starter - Pump 1-way 1-speed

### Single fan

There are (42) pumps controlled by this system.

VT010_F	NO.1 C/H EXH FAN(S)(E-31)	XC	Starter - Fan 1-way 1-speed
VT011_F	NO.1 C/H EXH FAN(S)(E-32)	XC	Starter - Fan 1-way 1-speed
VT012_F	NO.1 C/H EXH FAN(P)(E-33)	XC	Starter - Fan 1-way 1-speed
VT013_F	NO.2 C/H EXH FAN(S)(E-34)	XC	Starter - Fan 1-way 1-speed
VT014_F	NO.2 C/H EXH FAN(S)(E-35)	XC	Starter - Fan 1-way 1-speed
VT015_F	NO.2 C/H EXH FAN(P)(E-36)	XC	Starter - Fan 1-way 1-speed
VT016_F	NO.2 C/H EXH FAN(S)(E-37)	XC	Starter - Fan 1-way 1-speed
VT017_F	NO.2 C/H EXH FAN(S)(E-38)	XC	Starter - Fan 1-way 1-speed
VT018_F	NO.2 C/H EXH FAN(P)(E-39)	XC	Starter - Fan 1-way 1-speed
VT019_F	NO.3 C/H EXH FAN(S)(E-40)	XC	Starter - Fan 1-way 1-speed
VT020_F	NO.3 C/H EXH FAN(S)(E-41)	XC	Starter - Fan 1-way 1-speed
VT021_F	NO.3 C/H EXH FAN(S)(E-42)	XC	Starter - Fan 1-way 1-speed
VT022_F	NO.3 C/H EXH FAN(S)(E-43)	XC	Starter - Fan 1-way 1-speed
VT023_F	NO.3 C/H EXH FAN(S)(E-44)	XC	Starter - Fan 1-way 1-speed
VT024_F	NO.3 C/H EXH FAN(S)(E-45)	XC	Starter - Fan 1-way 1-speed
VT025_F	NO.3 C/H EXH FAN(S)(E-46)	XC	Starter - Fan 1-way 1-speed
VT026_F	NO.4 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT027_F	NO.4 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT028_F	NO.5 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT029_F	NO.5 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT030_F	NO.6 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT031_F	NO.6 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT032_F	NO.7 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT033_F	NO.7 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT034_F	NO.8 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT035_F	NO.8 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT036_F	NO.9 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT037_F	NO.9 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT038_F	NO.10 C/H SUP FAN(S)	XC	Starter - Fan 1-way 1-speed
VT039_F	NO.10 C/H SUP FAN(P)	XC	Starter - Fan 1-way 1-speed
VT042_F	S/G ROOM FAN RUN	XC	Starter - Fan 1-way 1-speed
VT043_F	B/T & EMCY FIRE PP RM FAN	XC	Starter - Fan 1-way 1-speed
VT044_F	NO.1 ACCOM UNDER DK SUP FAN	XC	Starter - Fan 1-way 1-speed
VT045_F	NO.2 ACCOM UNDER DK SUP FAN	XC	Starter - Fan 1-way 1-speed
VT046_F	NO.1 UNDER P/W FAN(S) RUN	XC	Starter - Fan 1-way 1-speed
VT047_F	NO.2 UNDER P/W FAN(S) RUN	XC	Starter - Fan 1-way 1-speed
VT048_F	NO.3 UNDER P/W FAN(S) RUN	XC	Starter - Fan 1-way 1-speed
VT049_F	NO.4 UNDER P/W FAN(S) RUN	XC	Starter - Fan 1-way 1-speed
VT050_F	NO.1 BOSUN STORE FAN	XC	Starter - Fan 1-way 1-speed
VT051_F	NO.2 BOSUN STORE FAN	XC	Starter - Fan 1-way 1-speed
VT052_F	NO.3 BOSUN STORE FAN	XC	Starter - Fan 1-way 1-speed
VT053_F	PIPE DUCT FAN RUN	XC	Starter - Fan 1-way 1-speed

## **2.2 Stand-by pumps**

### **2.2.1 Stand-by controller**

The main purpose of the stand-by pump controller is to control a stand-by pump system. The stand-by pump system may include 2 or 3 pumps with individual or common pressure switches. The stand-by controller provides automatic functions such as stand-by start on pressure drop and trip.

This stand-by controller operates 2 or 3 pumps, being 1 or 2 speed, or combinations of 1 and 2 speed pumps. A software module controls each pump. The starter provides simple pump control. The stand-by controller will monitor the starter logic and the system pressures. In case of stand-by starting a pump is required, the stand-by controller will give start command to the starter logic.

The stand-by controller uses one starter tag for each pump in the system.

### **2.2.2 Functions and options**

The stand-by pump controller will monitor the pressure signals and the running signals in a stand-by system. A pump will be started in case a stand-by start condition occurs. At restart after blackout, the stand-by pump controller monitors the restart sequence.

#### **Stand-by start at:**

- Pressure drop
- Trip

#### **Functions:**

- Monitor system pressure(s)
- Monitor running status
- Alarm reporting for stand-by start and non stand-by configuration
- Auto and semi-auto (manual) mode control
- Optional timestamp on every change of operation

### **2.2.3 Auto and manual**

Stand-by functionality is only in operation when the stand-by controller is set to auto mode. Operating in auto mode also requires that the controller is not blocked, or in other ways disabled from operating. It is also required that the pump starter is set to auto mode.

A stand-by pump is a pump selected as remote and auto, with no blocking or alarms. The stand-by pump is stand-by started at the conditions given above. A failing pump is set to not auto-mode (manual). The running pump does not have to be auto or remote.

### **2.2.4 Stand-by priority**

The stand-by pumps can be given a start priority, numbered 1 to 3. The stand-by pump with the highest priority (lowest number) will start first. If two pumps have the same priority, they will both be started (in sequence). A pump will keep its priority number both when running and when not in auto. The operator can change the priority number at any time.

### **2.2.5 Automatic stop of the failed master**

When the stand-by pump starts due to pressure drop, not trip, the failed master can be automatically stopped before or after starting the stand-by pump, or not stopped at all.

### **2.2.6 Stop master choices**

- Immediate stop of failed pump, i.e. before starting the stand-by pump
- At pressure return
- When the stand-by has started
- Parallel run with the started stand-by for a specified time interval, then stop the failed pump
- Do not stop the failed pump

### **2.2.7 Stand-by controller timers**

- Command timeout: Time delay before signalling command timeout

- Wait pressure at start: When a pump is starting, a stand-by pump is started if the pressure has not been established until timeout
- Pressure filter timer: The pressure is allowed to be low this long before starting a stand-by pump

### **2.2.8 Stand-by start**

Usually two signals will be used to control the stand-by start logic. These are the pressure switch signal from the pipe behind the pumps, and the running indication from the other pump(s). It is possible to activate the stand-by pump start either on dropping pressure signal, on stopping pump motor (trip) or on both pressure drop and pump trip. The stand-by will only start on pressure drop if the other pump is running at that time.

The stand-by logic can use one pressure switch for each pump or one pressure switch common for both pumps. Only one speed pumps are used.

As standard, all stand-by pumps are restarted after blackout. A separate restart delay timer is specified for each pump. Also, the stand-by start should be controlled by pressure switches. Analogue pressure sensors are configured into a gate tag that converts it to a binary signal.

### **2.2.9 Manual operation**

Manual operation means that the operator starts and stops the pump manually. This can be done from the Operator Station or from the MOS. The pump is set to manual for manual operation. Stand-by start from a manually stopped pump is not possible.



## 2.3 Pump control used for this project

2 pumps, 1 speed, 1 pressure switch

There are (10) pump sets controlled by this system.

<b>PP001_ST</b>	<b>MAIN L.O PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP001_P	NO.1 MAIN L.O PP	XC	Starter - Pump 1-way 1-speed
PP012_P	NO.2 MAIN L.O PP	XC	Starter - Pump 1-way 1-speed
ML026	MAIN LO PP CONT	PAL	Digital Input
<b>PP002_ST</b>	<b>S/T L.O PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP002_P	NO.1 S/T L.O PP	XC	Starter - Pump 1-way 1-speed
PP013_P	NO.2 S/T L.O PP	XC	Starter - Pump 1-way 1-speed
ML042	S/T LO PP CONT	DPAL	Digital Input
<b>PP004_ST</b>	<b>M/E JACKET C.F.W PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP004_P	NO.1 M/E JACKET C.F.W PP	XC	Starter - Pump 1-way 1-speed
PP016_P	NO.2 M/E JACKET C.F.W PP	XC	Starter - Pump 1-way 1-speed
MW042	M/E JACKET CFW PP CONT	PAL	Digital Input
<b>PP007_ST</b>	<b>G/E CIRC. PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP007_P	NO.1 G/E CIRC. PP	XC	Starter - Pump 1-way 1-speed
PP018_P	NO.2 G/E CIRC. PP	XC	Starter - Pump 1-way 1-speed
GG013	G/E CIRC PP CONT	DPAL	Digital Input
<b>PP008_ST</b>	<b>M/E F.O CIRC. PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP008_P	NO.1 M/E F.O CIRC. PP	XC	Starter - Pump 1-way 1-speed
PP019_P	NO.2 M/E F.O CIRC. PP	XC	Starter - Pump 1-way 1-speed
MF009	M/E FO CIRC PP CONT	PAL	Digital Input
<b>PP009_ST</b>	<b>M/E F.O SUPPLY PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP009_P	NO.1 M/E F.O SUPPLY PP	XC	Starter - Pump 1-way 1-speed
PP020_P	NO.2 M/E F.O SUPPLY PP	XC	Starter - Pump 1-way 1-speed
MF007	M/E FO SUPPLY PP CONT	PAL	Digital Input
<b>PP010_ST</b>	<b>G/E F.O BOOST. PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP010_P	NO.1 G/E F.O BOOST. PP	XC	Starter - Pump 1-way 1-speed
PP021_P	NO.2 G/E F.O BOOST. PP	XC	Starter - Pump 1-way 1-speed
GG012	G/E FO BOOST PP CONT	PAL	Digital Input
<b>PP011_ST</b>	<b>G/E F.O SUPPLY PP</b>	<b>XC</b>	<b>Standby Handler</b>
PP011_P	NO.1 G/E F.O SUPPLY PP	XC	Starter - Pump 1-way 1-speed
PP022_P	NO.2 G/E F.O SUPPLY PP	XC	Starter - Pump 1-way 1-speed
GG010	G/E FO SUPPLY PP CONT	PAL	Digital Input

PP023_ST	A/C COND CFW BOOST PP	XC	Standby Handler
PP023_P	NO.1 A/C COND CFW BOOST PP	XC	Starter - Pump 1-way 1-speed
PP024_P	NO.2 A/C COND CFW BOOST PP	XC	Starter - Pump 1-way 1-speed
MW043	AIR COND CFW BOOST PP CONT	PAL	Digital Input
PP042_ST	F.W PP FOR HYD UNIT	XC	Standby Handler
PP011_P	NO.1 F.W PP FOR HYD UNIT	XC	Starter - Pump 1-way 1-speed
PP022_P	NO.2 F.W PP FOR HYD UNIT	XC	Starter - Pump 1-way 1-speed
MW045	HYD UNIT FW PP CONT	PAL	Digital Input

### 2 pumps, 1 speed, 2 pressure switches

There are (1) pump set controlled by this system.

PP005_ST	BOILER FEED W. PP	XC	Standby Handler
PP005_P	NO.1 BOILER FEED W. PP	XC	Starter - Pump 1-way 1-speed
PP017_P	NO.2 BOILER FEED W. PP	XC	Starter - Pump 1-way 1-speed
AB034	NO.1 BOILER FEED W. PP CONT	PAL	Digital Input
AB036	NO.2 BOILER FEED W. PP CONT	PAL	Digital Input

### 3 pumps, 1 speed, 3 pressure switches

There are (1) pump set controlled by this system.

PP003_ST	CENT. C.F.W PP	XC	Standby Handler
PP003_P	NO.1 CENT. C.F.W PP	XC	Starter - Pump 1-way 1-speed
PP014_P	NO.2 CENT. C.F.W PP	XC	Starter - Pump 1-way 1-speed
PP015_P	NO.3 CENT. C.F.W PP	XC	Starter - Pump 1-way 1-speed
MW039	NO.1 CENT CFW PP CONT	PAL	Digital Input
MW040	NO.2 CENT CFW PP CONT	PAL	Digital Input
MW041	NO.3 CENT CFW PP CONT	PAL	Digital Input

## 3 COMPRESSED AIR SYSTEMS

### 3.1 Compressor controller

The main purpose of the compressor controller is to control the compressors in a compressed air system. The compressor control provides automatic functions such as automatic start and stop on pressure. The compressed air system may include one or more compressors with analogue or binary pressure signals. A software module called starter controller controls each compressor starter, which provides simple start and stop control.

#### 3.1.1 Compressor controller sub-types

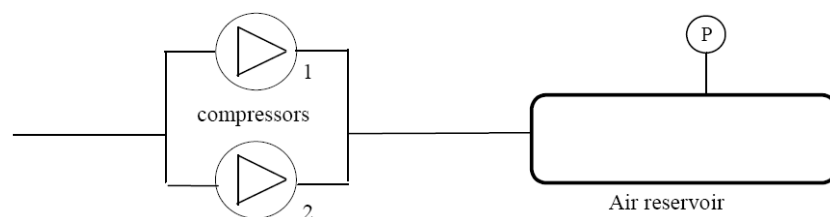
The compressor controller can operate as follows:

Sub-type	Name	Description
1	Analogue pressure 1	One analogue pressure
2	Analogue pressure 2	Two analogue pressures
3	Binary pressure with hysteresis	Pressure switches with built in hysteresis
4	Binary pressure without hysteresis	Separate pressure switches for start and stop

#### 3.1.2 Pressure signal

The figure below describes a compressor system with one common analogue pressure signal.

##### 2-compressor system with 1 common pressure sensor



If binary pressure switches are installed, the stop all pressure limits and the start leader limit is the minimum of what the controller requires. If one start switch is installed, the compressors can start on it directly or delayed.

### **3.1.3 Functions and options**

The compressor controller will monitor the pressure and running signals in a compressor system. Compressors will be started and stopped according to pressure status.

#### **Functions**

- Monitor system pressure(s)
- Monitor running status
- Alarm reporting for configuration error(s)
- Auto and manual mode control
- Optional timestamp on every change of operation
- Reporting signal fail on important sensors

### **3.1.4 Auto and not auto**

Automatic operation depends on the compressor controller and the starter controller being set to auto mode.

### **3.1.5 Sub-modes when in auto mode**

The compressor controller operates the compressors in the following sub-modes:

- Leader
- 1st follower
- 2nd follower
- 3rd follower

Leader and follower are sub-modes with different priority for start and stop. A compressor may only be in one of the sub-modes at the time. The leader is of higher order sub-mode than the 1st follower.

### **3.1.6 Priority**

Sub-mode is the same as priority or order. The sub-mode tells in which order the compressors shall start and stop. There may only be one compressor in each priority at the time.

The priority possibilities are:

0 = leader

1 = first follower

2 = second follower

3 = third follower

A system may only use as many sub-modes as there are compressors in the system. A two compressor system operates with leader and follower. A one compressor system operates with one leader only.

### **3.1.7 Safety**

All sub-modes are stopped at the leader stop setting. For analogue systems all sub-modes are stopped by alarm high high from the analogue sensor.

## **3.2 Compressor controller parameters**

There can be listed up to four compressor tags. If three tags are listed, the system is a three-compressors system. If four tags are listed, the system is a four-compressors system.

### **Pressure tags**

Analogue pressure requires a number of start and stop limits. Binary pressure requires one start I/O per compressor, and one common stop I/O.

### **Compressor controller timers**

- Command timeout: This is how long time the controller will wait before signalling command timeout.
- Pressure filter: The pressure may stay low this long before the compressor is started.
- Wait pressure at start: When a compressor is starting, a new compressor is started if the pressure is not been established until this timer has expired.
- Blackout recover: The compressors are blocked from auto starting this long after a blackout.

### 3.3 The compressor start/stop conditions

The following is a description of the conditions for starting and stopping the compressors in a compressor system. There are different conditions for compressor start/stop; the conditions are adjustable with parameters.

#### Start

There are separate start settings for each sub-mode, both for binary and analogue pressure.

- Pressure lower than start setting in the actual sub-mode (priority)
- On time after start conditions on higher order sub-mode

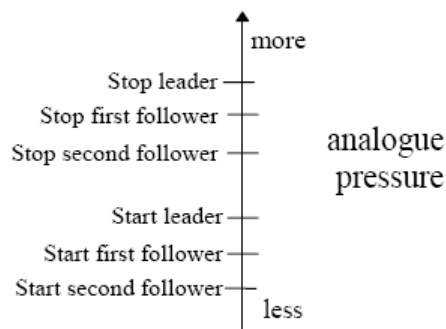
#### Stop

The stop setting can be equal for all compressors, or individual. For analogue pressure, there are separate stop settings to each sub-mode. For binary pressure, separate inputs can be defined for stop in each sub-mode. There may also be defined one common stop input. All sub-modes are stopped by the stop leader setting.

- Pressure higher than stop setting in the actual sub-mode
- Stop leader active
- High-high pressure at the actual pressure tag.

#### Auto

Compressor automation functionality is in operation when the compressor controller is set to auto mode. Auto mode is a software parameter, changeable by operator. Operating in auto mode also requires that the controller is not blocked, or in other ways disabled from operating. The starter controller controlling a compressor will have to be set to auto, so that it can be controlled from the compressor controller.



*Figure 1. Start and stop settings with analogue system pressure*

### Sub-mode

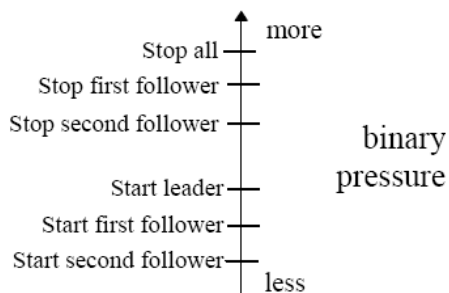
Sub-mode is the priority number on which the compressor will be stopped and started. The sub-mode can be changed at any time. Each compressor needs to have a unique sub-mode, there may not be two leaders etc. The controller will arrange this.

A compressor that is set to local, or is in other ways not controllable from the compressor controller, will keep its sub-mode. The sub-mode “non-sub” does not have any own start or stop settings, and will stop on leader stop setting and on emergency stop. The leader is of a higher ranged sub-mode than 1st follower, and the first follower is higher than the 2nd follower.

### Settings

Each sub-mode has its own settings for automatic start and stop. They can be set individually, but has to follow the figure below. The start setting for the 1st follower must be lower or equal to the leader start setting and the stop setting for the first follower must be lower or equal to the leader stop setting.

The following are examples on start and stop automation.



*Figure 2. Start and stop settings with binary system pressure*

### Leader control

The leader compressor has its own settings for start and stop limits.

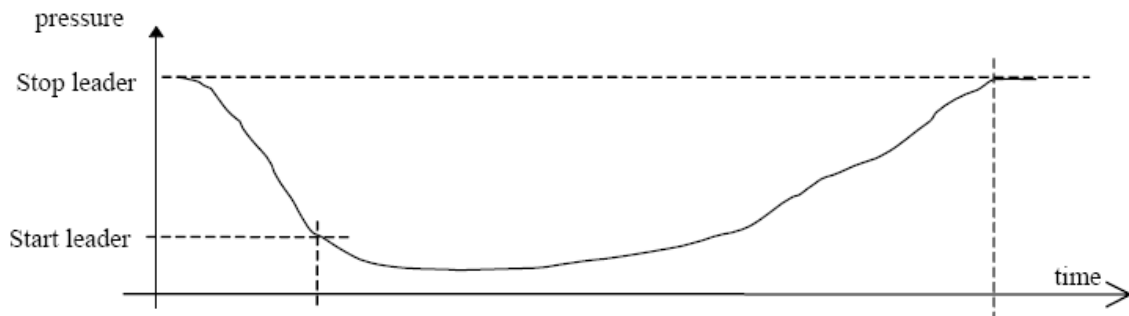


Figure 3. Leader start and stop

### Start follower on pressure drop

Each sub-mode has its own start and stop setting. The compressor set to a sub-mode will start when the pressure lowers below the start setting, and stop when the pressure rises above the stop setting.

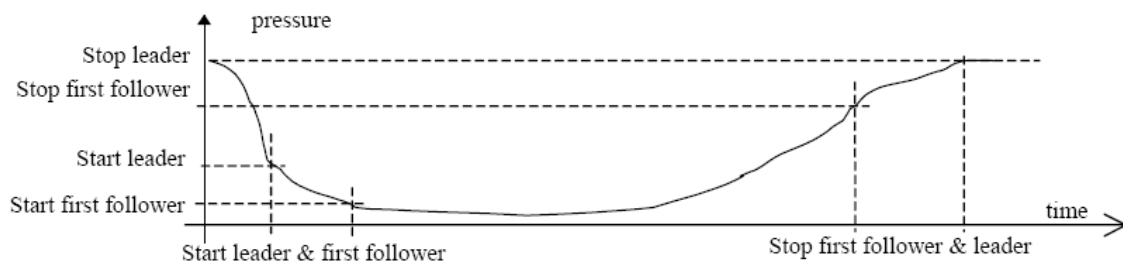


Figure 4. Start first follower on pressure setting

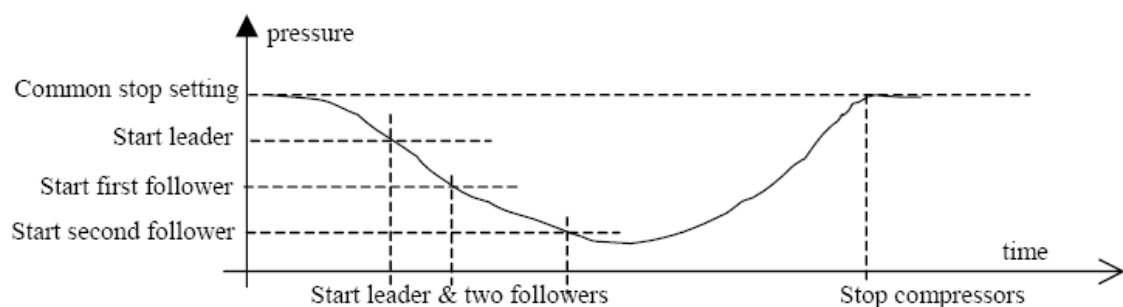


Figure 5. Start two followers on pressure setting



### Start follower on time delay

The 1st follower can start on its own pressure setting, or on a timer when there is a start condition for the leader compressor. The 2nd and 3rd followers will start in similar ways. There is no delayed start on the start condition for the topping up compressor.

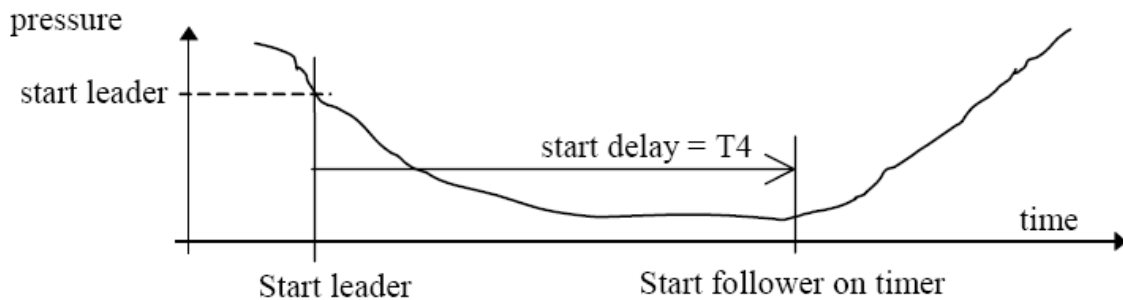


Figure 6. Start follower on timer - principal diagram

In the figure below the third follower will start on timer. The timer is started when the second follower has start conditions. If the pressure falls below third follower's start setting before the timer has expired, the third follower will start on this start setting.

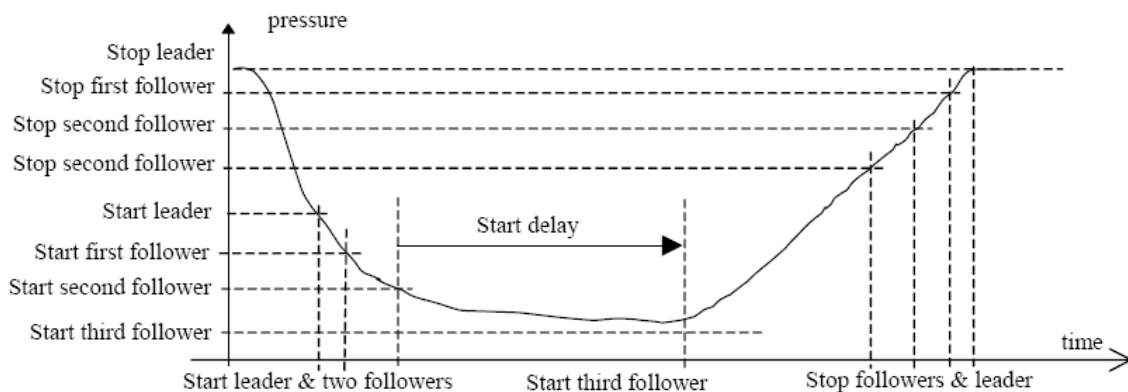


Figure 7. Start followers on timer

The followers are started on timer. The timer is started when the leader has start conditions. If the first and second compressor does not start on their own start settings, the third follower is started 3 times the start delay after the leader had its start condition.

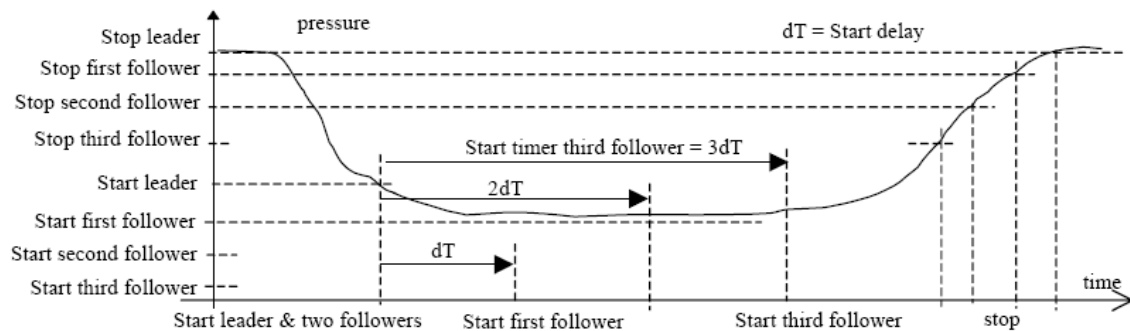


Figure 8. Follower start timers

The followers are started on timer. The timer is started when the leader has start conditions. If the first compressor has start condition on own setting, the second and third followers will reset their timers, and count the time from this event. If the second compressor has start condition on its own setting, the third will reset its timer again, and count the time from this event.

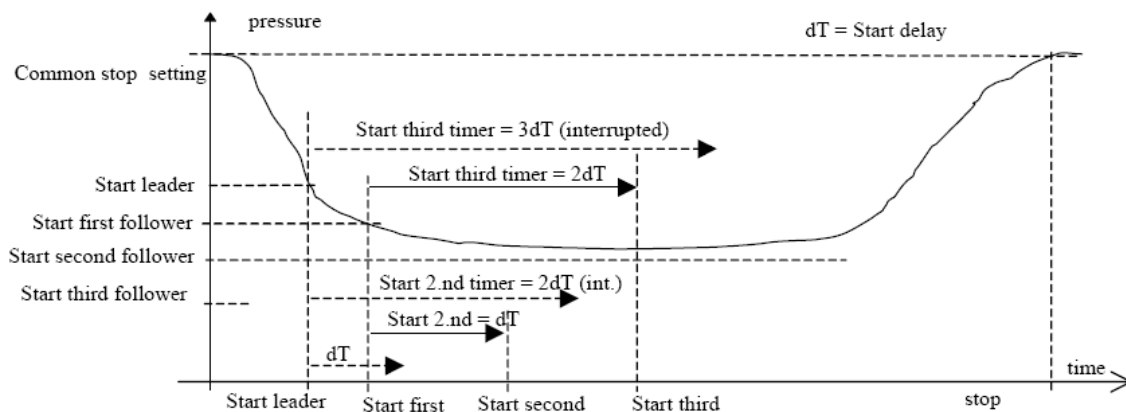


Figure 9. Interrupted start timer

### Built-in hysteresis

This program operates according to two pressure switches:

- The leader will start and stop on the high pressure switch only
- The follower will start and stop in correspondence with the state of the low pressure switch only

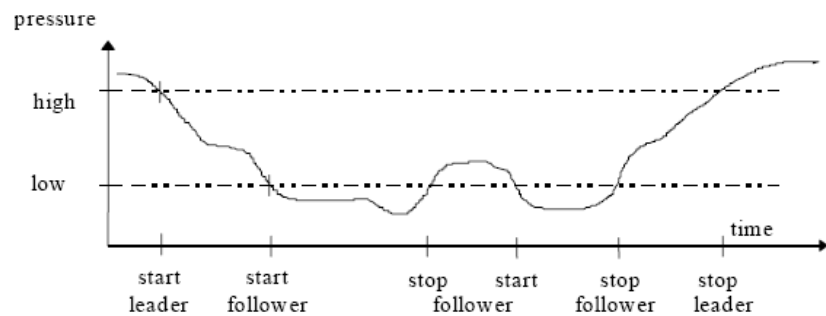


Figure 10. Built in hysteresis

By adjusting the pressure switches differently, the two compressors may function as a pair, where one starts before the other.

### Two analogue pressures

Two analogue pressures act in the same way as one. The compressors are started if one the pressures decrease below the start settings. The compressors are stopped as soon as both of the pressures increase above the stop setting.

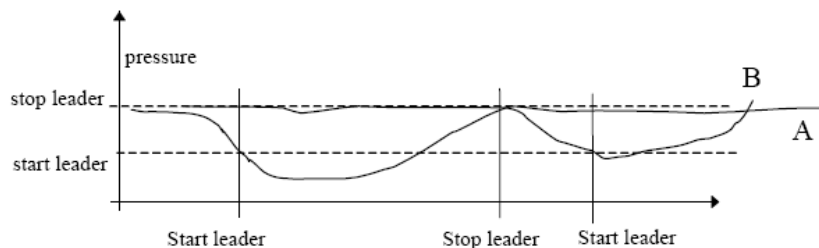


Figure 11. Two analogue pressures

The drawing shows the principal of the start and stop logic when the compressors are controlled by two pressure sensors. In real life the two sensors will show the same pressure.

### Overhaul mode

In a two reservoir system as described above, there is an overhaul function, i.e. when a reservoir is disabled from being part of the auto start and stop logic. Overhaul is individual to each reservoir.

There are two ways of setting a reservoir to overhaul:

- Set the belonging pressure sensors to offscan. The sensor is not considered when calculating the auto start and stop of the compressors.

- Separate input, one for each reservoir. This can be a button in the mimics or any tag reference.

The separate input is normally a manual push-button in the compressed air system mimics.

## 3.4 Compressor control used for this project

### Binary pressure with hysteresis

There are (1) compressor set controlled by this system.

CA023_C	NO.1 MAIN AIR COMP	XC	Starter - Compressor
CA024_C	NO.2 MAIN AIR COMP	XC	Starter - Compressor
CA025_C	NO.3 MAIN AIR COMP	XC	Starter - Compressor
CA026_C	TOPPING-UP AIR COMP	XC	Starter - Compressor
MA033	NO.1 MAIN AIR COMP. START/STOP	PAL	Digital Input
MA034	NO.2 MAIN AIR COMP. START/STOP	PAL	Digital Input
MA035	NO.3 MAIN AIR COMP. START/STOP	PAL	Digital Input
MA036	TOPPING UP AIR COMP START/STOP	PAL	Digital Input

## 4 VALVE CONTROL

### 4.1 Position controller

The position controller is used for control and positioning of valves, and for speed control of frequency controlled motors.

#### 4.1.1 Functions and options

The following functions and features are available:

- Monitoring the controlled object
- Pulse or analogue control of valves with analogue feedback
- Block from opening
- Block from closing
- Block from operation (local)
- Deviation monitoring
- Update alarm status
- Update event status
- Optional timestamp on every change of operation, i.e. recording time of positioning

#### 4.1.2 Positioning types

The position controller can operate the following configurations:

##### On-off valves

Sub-type	Name	Description
1	Single acting	One relay for control
1.1	Single acting with one feedback	One relay for control and one binary feedback
1.2	Single acting with two feedbacks	One relay for control and two binary feedbacks
1.3	Single acting with no feedback	No feedback, only single acting control
2	Double acting	Two relays for control

<b>Sub-type</b>	<b>Name</b>	<b>Description</b>
2.1	Double acting with one feedback	Two relays for control and one binary feedback
2.2	Double acting with two feedbacks	Two relays for control and two binary feedbacks
2.3	Double acting with no feedback	No feedback, only double acting control

Steady on, deactivate at feedback or finishing pulse can be defined. Monitoring means that only the binary feedbacks are interfaced to the positioner, and no relay or other control is provided. Analogue input tags handle analogue feedback, no positioner is provided.

#### **Analogue positioning valves**

<b>Sub-type</b>	<b>Name</b>	<b>Description</b>
3	Analogue out	Step-less positioning
3.1	Analogue out with analogue feedback	Step-less control with analogue feedback
4	Double acting positioning	Pulsed positioning
4.1	Double acting with analogue feedback	Pulsed positioning with analogue valve feedback
4.2	Double acting with one analogue feedback and two binary feedbacks	Pulsed positioning with one analogue valve feedback and two binary end feedbacks

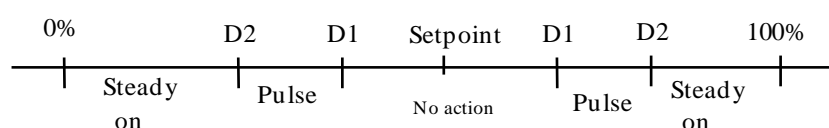
#### **Monitoring**

<b>Sub-type</b>	<b>Name</b>	<b>Description</b>
5	Monitoring	No control, only binary feedbacks
5.1	One feedback	No control, only one binary

Sub-type	Name	Description
		feedbacks
5.2	Two feedbacks	No control, only two binary feedbacks

### Dead bands (pulsed positioning)

Outside D2 the relays will be steady on until inside D2. If the feedback is between D2 and D1, the relays will be pulsing. When the feedback is closer to the set-point than D1, no positioning is performed.



### Moving

An additional relay can be activated when moving. If more than one relay uses the moving info relay, the relay will stay active for a preset time after the last valve stops moving.

### Follow mode

When in follow mode, the analogue output value will follow the value of a separate input tag. This is for analogue output control only.

### Auto mode

When in auto mode the positioning command will be the input value at a separate tag input if this input is defined. This is for analogue output control only.

## 4.1.3 Type of operation

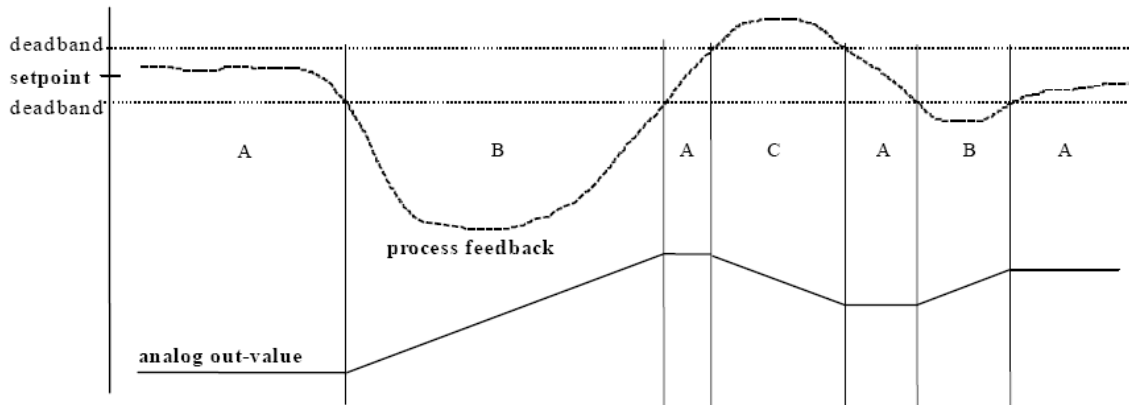
The position controller has 5 main control methods:

- On-off with steady control: Steady relay
- On-off with pulsed control: Pulsed relay, deactivate at feedback or finishing pulse
- Analogue positioning: Pulsed into a position between 0 and 100 %
- Step-less: Analogue command (between 0 and 100 %)
- Monitoring: No control, valve monitoring only

The position controller will check its I/O and parameter setting, and automatically select type of operation.

### Step-less positioning

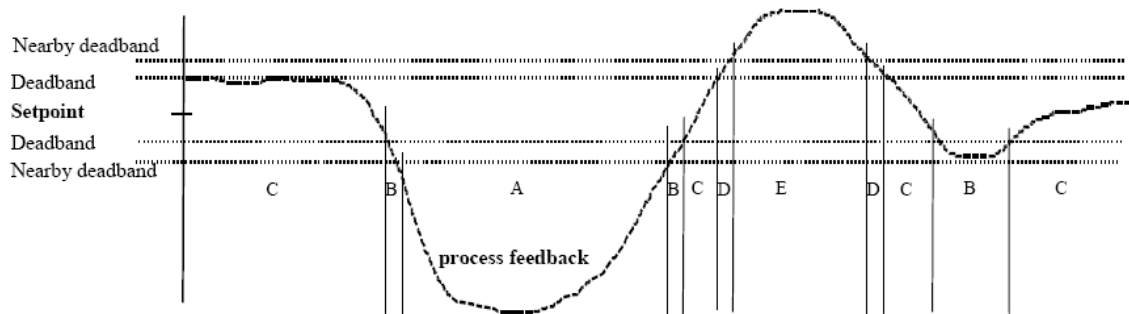
Both feedback and control signals are analogue.



The analogue output position controller is described in the figure above. There are three modes of operation:

- (A) The output value will be at a steady value as long as the process feedback is inside the dead band.
- (B) If the feedback is below the dead band, the output value will increase until the process feedback is inside the dead band again.
- (C) If the process feedback is above the dead band, the analogue out-value will decrease until the feedback is inside the dead band again.

### Positioning with digital output



The digital outputs described in the figure above. There are five modes of operation:

- (C) The outputs will be at steady open as long as the process feedback is inside the dead band.
- (E) If the process feedback is above the nearby dead band, the close output will be kept steady until the process feedback is inside the nearby dead band again.

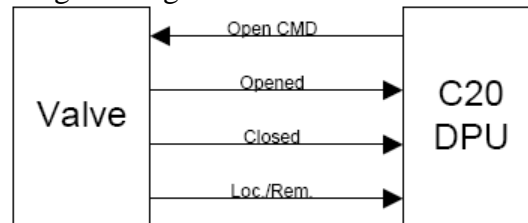


(A) If the process feedback is below the nearby dead band, the open output will be kept steady until the process feedback is inside the nearby dead band again.

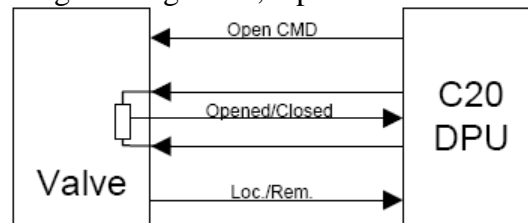
(D) If the process feedback is inside nearby dead band but above the dead band, the close output will pulse until the feedback is inside the dead band again.

(B) If the process feedback is inside nearby dead band but below the dead band, the open output will pulse until the feedback is inside the dead band again.

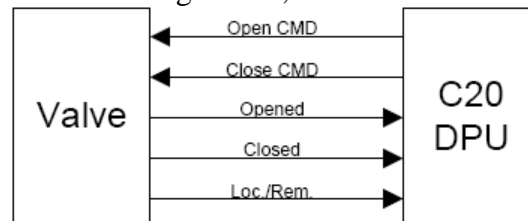
Single acting valve 1 or 2 limit switches



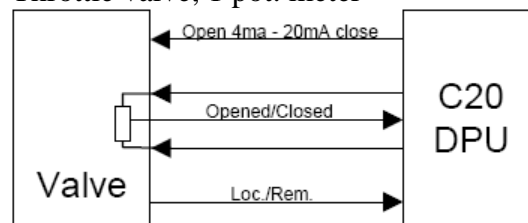
Single acting valve, 1 pot. meter



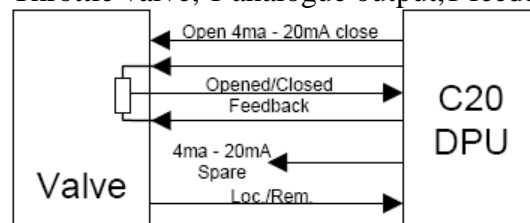
Double acting valves, 1 or 2 limit switches



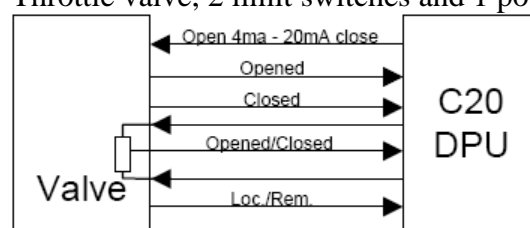
Throttle valve, 1 pot. meter



Throttle valve, 1 analogue output, 1 feedback



Throttle valve, 2 limit switches and 1 pot. meter



## 4.2 Valve control used for this project

### Single acting with analogue feedback

There are (4) valves controlled by this system.

BA055_V	NO.1 WBP FILL TO WBT V/V	XC	Positioner - Analogue pulsed
BA056_V	NO.2 WBP FILL TO WBT V/V	XC	Positioner - Analogue pulsed
BA057_V	NO.1 WBP DISCH V/V	XC	Positioner - Analogue pulsed
BA058_V	NO.2 WBP DISCH V/V	XC	Positioner - Analogue pulsed

### Single acting with two feedbacks

There are (85) valves controlled by this system.

BA001_V	NO.2 LS&DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA002_V	NO.2 LS&DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA003_V	MAIN LINE CROSS-OVER V/V	XC	Positioner - On Off Pulsed
BA004_V	NO.3 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA005_V	NO.3 SWBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA006_V	NO.3 LS&DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA007_V	NO.3 LS&DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA008_V	NO.4 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA009_V	NO.4 SWBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA010_V	NO.4 LS WBT(S)F/S V/V	XC	Positioner - On Off Pulsed

## Functional Description K-Chief 500/600 Control System

BA011_V	NO.4 LS WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA012_V	NO.4 DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA013_V	NO.4 DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA014_V	NO.5 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA015_V	NO.5 SWBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA016_V	NO.5 LS WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA017_V	NO.5 LS WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA018_V	NO.5 DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA019_V	NO.5 DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA020_V	MAIN LINE(S) ISOL.V/V	XC	Positioner - On Off Pulsed
BA021_V	MAIN LINE(P) ISOL.V/V	XC	Positioner - On Off Pulsed
BA022_V	NO.6 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA023_V	NO.6 SWBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA026_V	NO.6 LS WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA027_V	NO.6 LS WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA028_V	NO.6 DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA029_V	NO.6 DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA030_V	NO.7 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA031_V	NO.7 SWBT(P) FILL/SUC V/V	XC	Positioner - On Off Pulsed
BA032_V	NO.7 LS WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA033_V	NO.7 LS WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA034_V	NO.7 DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA035_V	NO.7 DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA036_V	NO.8 SWBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA037_V	NO.8 SWBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA038_V	NO.8 LS WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA039_V	NO.8 LS WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA040_V	NO.8 DB WBT(S)F/S V/V	XC	Positioner - On Off Pulsed
BA041_V	NO.8 DB WBT(P)F/S V/V	XC	Positioner - On Off Pulsed
BA042_V	NO.9 WBT(S) F/S V/V	XC	Positioner - On Off Pulsed
BA043_V	NO.9 WBT(P) F/S V/V	XC	Positioner - On Off Pulsed
BA044_V	MAIN LINE CROSS-OVER V/V	XC	Positioner - On Off Pulsed
BA045_V	NO.1 WBP.S/CHE.SUC V/V	XC	Positioner - On Off Pulsed
BA046_V	NO.2 WBP.S/CHE.SUC V/V	XC	Positioner - On Off Pulsed
BA047_V	NO.1 W.B.P.MAIN SUC V/V	XC	Positioner - On Off Pulsed
BA048_V	NO.2 W.B.P.MAIN SUC V/V	XC	Positioner - On Off Pulsed
BA049_V	NO.1 BWTS FT.IN V/V	XC	Positioner - On Off Pulsed
BA050_V	NO.2 BWTS FT.IN.V/V	XC	Positioner - On Off Pulsed
BA051_V	NO.1 BWTS FT.BY-PASS V/V	XC	Positioner - On Off Pulsed
BA052_V	NO.2 BWTS FT.BY-PASS V/V	XC	Positioner - On Off Pulsed
BA053_V	NO.1 BWTS FT.OUTLET V/V	XC	Positioner - On Off Pulsed
BA054_V	NO.2 BWTS FT.OUTLET V/V	XC	Positioner - On Off Pulsed
BA059_V	PP OVBD DISCH V/V	XC	Positioner - On Off Pulsed

## Functional Description K-Chief 500/600 Control System

---

BA062_V	NO.1 BWTS BY-PASS V/V	XC	Positioner - On Off Pulsed
BA063_V	NO.2 BWTS BY-PASS V/V	XC	Positioner - On Off Pulsed
BG001_V	IMD.BG.AIR DRI.PP DIS V/V	XC	Positioner - On Off Pulsed
BG002_V	NO.1 HOLD BW SUC V/V	XC	Positioner - On Off Pulsed
BG003_V	NO.2 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG004_V	NO.2 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG005_V	NO.3 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG006_V	NO.3 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG007_V	BILGE MAIN ISO.V/V	XC	Positioner - On Off Pulsed
BG008_V	NO.4 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG009_V	NO.4 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG010_V	PIPE DUCT F.BG.SUC V/V	XC	Positioner - On Off Pulsed
BG011_V	NO.5 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG012_V	NO.5 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG013_V	NO.6 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG014_V	NO.6 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG015_V	NO.7 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG016_V	NO.7 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG017_V	NO.8 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG018_V	NO.8 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG019_V	NO.9 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG020_V	NO.9 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
BG021_V	NO.10 HOLD BW SUC(S) V/V	XC	Positioner - On Off Pulsed
BG022_V	NO.10 HOLD BW SUC(P) V/V	XC	Positioner - On Off Pulsed
FO001_V	NO.1 HFO BT(S) V/V	XC	Positioner - On Off Pulsed
FO002_V	NO.1 HFO BT(P) V/V	XC	Positioner - On Off Pulsed
FO003_V	NO.2 HFO BT(S) V/V	XC	Positioner - On Off Pulsed
FO004_V	NO.2 HFO BT(P) V/V	XC	Positioner - On Off Pulsed
FO005_V	NO.3 HFO BT(S) V/V	XC	Positioner - On Off Pulsed
FO006_V	LS HFO BT(P) V/V	XC	Positioner - On Off Pulsed
FO007_V	OVERFLOW TK NO.1 SUC.V/V	XC	Positioner - On Off Pulsed
FO008_V	OVERFLOW TK NO.2 SUC.V/V	XC	Positioner - On Off Pulsed

## **5 ENGINEER SAFETY SYSTEM**

The engineer safety (or dead man) system is a system for man fitness. When activated, the reset button must be pressed within predefined time periods. The system will indicate dead man alarm if the reset buttons are not pressed within this time period.

When activated, the system will activate a rotating light after expired time delay. The operator should now reset the system. If the system is not reset within a new time period, the system will activate an alarm. Reset can be pressed at any time.

The system is activated and de-activated manually by a key-switch. The system will also be activated automatically from the alarm system when an engine room alarm occurs during unattended Engine Room.

## 6 BALLAST AND FUEL TANK MONITORING

### 6.1 Level measurement by pressure transmitters

The sensors which are used for level monitoring are measuring the pressure of the liquid gauge above the sensor. The signal from each sensor is 4-20 mA. The sensors are directly connected to the DPUs. Level transmitters are interfaced from the following tanks:

#### **Ballast tanks**

38 pcs. *Ballast tanks*

4 pcs. *Draft measurement (Fwd, Port/Stbd.,Aft)*

#### **Fuel tanks**

12 pcs. *HFO tanks*

5 pcs. *MGO tanks*

#### **Other tanks**

2 pcs. *FW tanks*

1 pc. *Boiler water tanks*

### 6.2 Conversion from level to volume

The tank tables are received from the shipyard and are loaded into the Operator Station's computer. Based on the measured level and density, the volume is calculated individually for each tank.

There are 58 tanks with volume calculation as follows:

MF038	HFO SERVICE TK LEVEL	LI	4 - 20 mA
MF042	LS HFO SERVICE TK LEVEL	LI	4 - 20 mA
MF046	HFO SETT TK LEVEL	LI	4 - 20 mA
MF050	LS HFO SETT TK LEVEL	LI	4 - 20 mA
MF054	MGO STORAGE TK 1 LEVEL	LI	4 - 20 mA
MF058	MGO STORAGE TK 2 LEVEL	LI	4 - 20 mA
MF062	MGO STORAGE TK 3 LEVEL	LI	4 - 20 mA
MF066	MGO STORAGE TK 4 LEVEL	LI	4 - 20 mA
MF070	MGO SERVICE TK LEVEL	LI	4 - 20 mA

## Functional Description K-Chief 500/600 Control System

MF017	NO.1 HFO BUNK TK(P) LEVEL	LI	4 - 20 mA
MF020	NO.1 HFO BUNK TK(S) LEVEL	LI	4 - 20 mA
MF023	NO.2 HFO BUNK TK(P) LEVEL	LI	4 - 20 mA
MF026	NO.2 HFO BUNK TK(S) LEVEL	LI	4 - 20 mA
MF029	NO.3 HFO BUNK TK(S) LEVEL	LI	4 - 20 mA
MF032	LS HFO BUNK TK(P) LEVEL	LI	4 - 20 mA
MF035	FWD HFO OVERFLOW TK LEVEL	LI	4 - 20 mA
MF074	E/R HFO OVERFLOW TK LEVEL	LI	4 - 20 mA
MW029	FW TK(P) LEVEL	LI	4 - 20 mA
MW032	FW TK(S) LEVEL	LI	4 - 20 mA
AB022	BOILER WATER TK LEVEL	LI	4 - 20 mA
BA114	NO.2 L.S & D.B W.B TK(P) LEVEL	LI	4 - 20 mA
BA117	NO.2 L.S & DB W.B TK(S) LEVEL	LI	4 - 20 mA
BA120	NO.3 L.S & D.B W.B TK(P) LEVEL	LI	4 - 20 mA
BA123	NO.3 L.S & D.B W.B TK(S) LEVEL	LI	4 - 20 mA
BA126	NO.3 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA129	NO.3 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA132	NO.4 D.B W.B TK(P) LEVEL	LI	4 - 20 mA
BA135	NO.4 D.B W.B TK(S) LEVEL	LI	4 - 20 mA
BA138	NO.4 L.S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA141	NO.4 L.S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA144	NO.4 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA147	NO.4 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA150	NO.5 D.B W.B TK(P) LEVEL	LI	4 - 20 mA
BA153	NO.5 D.B W.B TK(S) LEVEL	LI	4 - 20 mA
BA156	NO.5 L.S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA159	NO.5 L.S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA162	NO.5 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA165	NO.5 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA168	NO.6 D.B.W.B TK(P) LEVEL	LI	4 - 20 mA
BA171	NO.6 D.B.W.B TK(S) LEVEL	LI	4 - 20 mA
BA174	NO.6 L.S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA177	NO.6 L.S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA180	NO.6 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA183	NO.6 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA186	NO.7 D.B.W.B TK(P) LEVEL	LI	4 - 20 mA
BA189	NO.7 D.B.W.B TK(S) LEVEL	LI	4 - 20 mA
BA192	NO.7 L.S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA195	NO.7 L.S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA198	NO.7 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA201	NO.7 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA204	NO.8 L.S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA207	NO.8 L.S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA210	NO.8 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA213	NO.8 S.W.B TK(S) LEVEL	LI	4 - 20 mA
BA216	NO.8 D.B.W.B TK(P) LEVEL	LI	4 - 20 mA
BA219	NO.8 D.B.W.B TK(S) LEVEL	LI	4 - 20 mA
BA222	NO.9 S.W.B TK(P) LEVEL	LI	4 - 20 mA
BA225	NO.9 S.W.B TK(S) LEVEL	LI	4 - 20 mA

## 6.3 Interface to load calculator

The Load calculator interfaced is:

*Seacos Load and Stability Calculator (NCADL 94)*

The tank level data is transferred as raw data to the load calculator. The calculated tank measurement compensated for trim/list, density and temperature is sent back to the K-Chief 600 .



## 7 BALLAST WATER TREATMENT SYSTEM

### 7.1 Interface to ballast water treatment system

The K-Chief 600 is interfaced to a ballast water treatment system delivered by:

*Panasia Ballast water treatment system (Modbus)*

### 7.2 Valves control for Ballast water treatment.

There are 15 valves for BWTS as follows:

- BA45/BA46/BA47/BA48/BA49/BA50/BA51/BA52/BA53
- BA54/BA55/BA56/BA57/BA58/BA59/BA62/BA63

*Green coloring valves are valves in BWTS units.*

*Black coloring valves are valves out of BWTS units, but related to BWTS.*

#### 7.2.1 Valve control position.

Valves control position is to be defined by following signal:

BWTS-MODE	VALVE CONTROL POSITION	XO	4 - 20 mA out
-----------	------------------------	----	---------------

When BWTS-MODE is on(1), control position is BWTS, when BWTS-MODE is off(2), control position is K-Chief 600 system.

#### 7.2.2 Valves control request and feedback signals.

When control position is BWTS, following signals are to be K-Chief 600 from BWTS,

BA049_CMD	BA49 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA050_CMD	BA50 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA051_CMD	BA51 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA052_CMD	BA52 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA053_CMD	BA53 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA054_CMD	BA54 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA062_CMD	BA62 V/V OPEN/CLOSE REQUEST	XI	Serial Analog
BA063_CMD	BA63 V/V OPEN/CLOSE REQUEST	XI	Serial Analog

Feedback for request are as follows:

BA049_FB	BA49 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA050_FB	BA50 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA051_FB	BA51 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA052_FB	BA52 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA053_FB	BA53 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA054_FB	BA54 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA062_FB	BA62 V/V OPENED/CLOSED	XO	4 - 20 mA out
BA063_FB	BA63 V/V OPENED/CLOSED	XO	4 - 20 mA out

i.e). Panasia BWTS does not control valves directly. The valve control is always by K-Chief 600 system. Panasia BWTS send control request to K-Chief 600 system for valves in BWTS units.

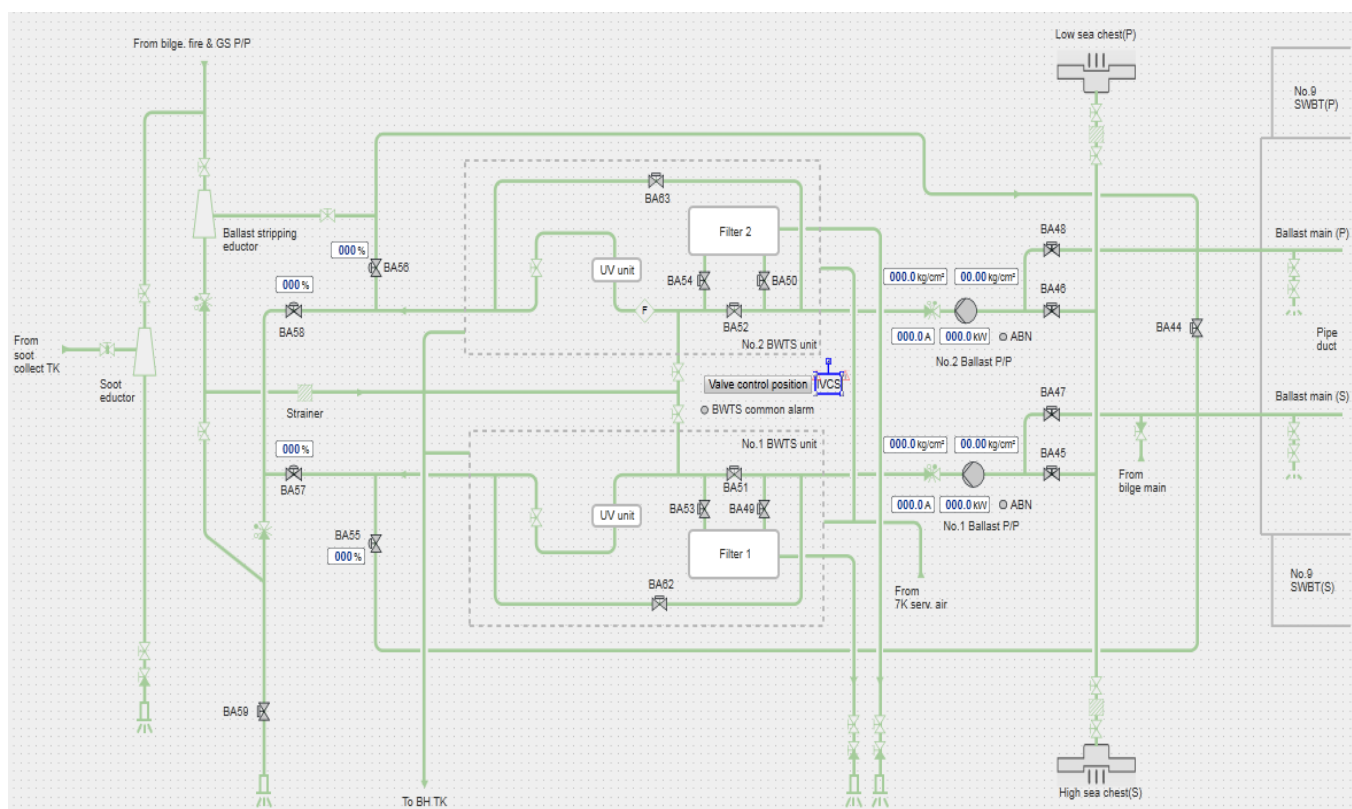
### 7.2.3 Valves status to BWTS.

Followings 9 valves position status are to BWTS.

BA045_FB	BA45 V/V OPENED/CLOSED	XO	4 - 20 mA out	
BA046_FB	BA46 V/V OPENED/CLOSED	XO	4 - 20 mA out	
BA047_FB	BA47 V/V OPENED/CLOSED	XO	4 - 20 mA out	
BA048_FB	BA48 V/V OPENED/CLOSED	XO	4 - 20 mA out	
BA059_FB	BA59 V/V OPENED/CLOSED	XO	4 - 20 mA out	
BA055_FB	BA55 V/V POSITION	XO	4 - 20 mA out	%
BA056_FB	BA56 V/V POSITION	XO	4 - 20 mA out	%
BA057_FB	BA57 V/V POSITION	XO	4 - 20 mA out	%
BA058_FB	BA58 V/V POSITION	XO	4 - 20 mA out	%

Any request is not come from BWTS, K-Chief 600 system gives BWTS position status of the valves continuously.

## 7.3 BWTS on K-Chief 600 system



## 8 PUMP AUTO CONTROL

### 8.1 H.F.O Transfer pump

HFO transfer pump is controlled by K-Chief 600 system automatically.

It is required that Starters of HFO transfer pump is both remote selected and Auto Mode.

#### 8.1.1 HFO transfer pump Auto Start/Stop

Auto Start/Stop of HFO transfer pump by HFO sett.tank or LS HFO sett. Tank level.

A HFO sett.tank is to be selected by a Button on MIMIC.

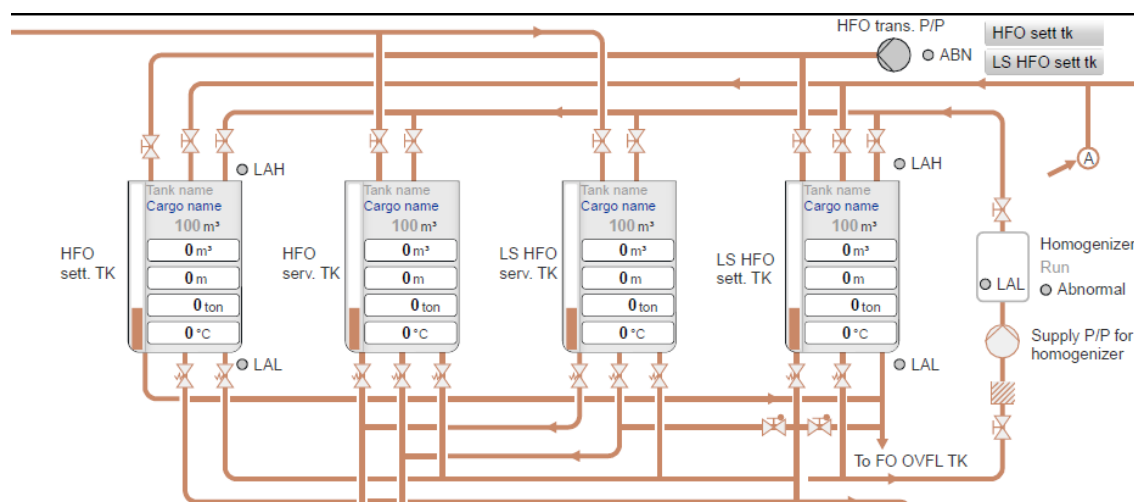
Selected tank levels are reference of HFO transfer pump Auto Start/Stop.

References are as follows:

MF013	HFO SETTling TK L.L	LCL
MF014	HFO SETTling TK L.H	LCH
MF015	LS HFO SETTling TK L.L	LCL
MF016	LS HFO SETTling TK L.H	LCH

Green colors are for Auto Start, red colors are for Auto Stop.

Below mimic pages is cut out from FO purifying system.



## 8.2 M.G.O Transfer pump

MGO transfer pumps are controlled by K-Chief 600 system automatically.

It is required that Starters of MGO transfer pump is both remote selected and Auto Mode.

### 8.2.1 MGO transfer pump Auto Stop

Auto Stop of MGO transfer pump by MGO serv.tank or Incinerator MGO tank.

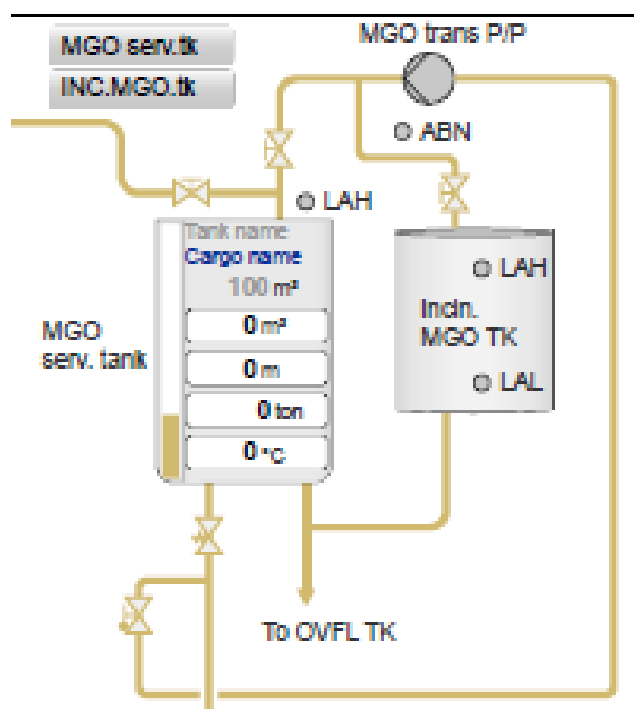
A tank is to be selected by a Button on MIMIC.

Selected tank level high is reference of MGO transfer pump auto stop.

References are as follows

MF121	MGO SERVICE TK L H	LCH
BS037	INC. MDO/MGO TK L.H	LCH

Below mimic pages is cut out from FO purifying system.



## 8.3 Oily bilge pump

Oily bilge pump is controlled by K-Chief 600 system automatically.

It is required that Starters of Oily bilge pump is both remote selected and Auto Mode.

### 8.3.1 Oily bilge pump Auto Start/Stop

Auto Start/Stop of Oily bilge pump by Oily bilge tank and E/R aft.bilge well.

References are as follows:

BS032	OILY BILGE TK L.L CONT	LCL
BS031	E/R AFT BILGE WELL L.H CONT	LCH

Green color is for Auto Start, red color is for Auto Stop.

## 8.4 Sludge pump

Sludge pump is controlled by K-Chief 600 system automatically.

It is required that Starters of Sludge pump is both remote selected and Auto Mode.

### 8.4.1 Sludge pump Auto Stop

Auto Stop of Sludge pump by Incinerator W.O sett.tank level.

References are as follows:

BS036	INC. W.O SETT TK L.H	LCH
-------	----------------------	-----