

## Functional Description

Warm-up & prelubrication logic

Generator Control Unit

Severnaya hull no. 431

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## 1.0 INTRODUCTION

The standard software for Norcontrol Generator Control Unit is extended with new logic for warming up the dieselengine before the dieselpgenerator is being connected to the busbar. In relation to this update the primer pump logic is also extended. These upgrades are implemented on software version 17011-CB and newer. The logic is made, based upon logic diagrams from AURORA ASS. The SEVERNAYA hull no. 431 is the first project with this upgrade.

## 2.0 PARAMETER SETUP:

For implementation of the warm-up logic, the custom specified inputs on the GCU has to be used (max. 5 inputs). The inputs needed are limitswitches for upper and lower position of the pilotmotor on the engine speed governor. (The pilotmotor controls the speed setpoint between 43.5 Hz and 50.7 Hz on this project).

In addition the GCU needs an input for minimum warm engine.

All inputs are programmed by use of the parameter C1:

C1 = 10: Warm engine input logic.

C1 = 11: Limitswitch for lower position.

C1 = 12: Limitswitch for upper position.

When the inputs are active the corresponding front-led will be lit.

It is important to set up the parameters for warm-up logic as specified below, ref opcode 5, 6 and 8.

For implementation of the primer-pump logic it is important to set the opcode parameter is specified in the table below, ref opcode 4 and 34.

### 2.1 Project related parameter setup:

Opc- ode	Chan -nel	Par- am.	X- ref.	Description	Value
4	6	C1	X4	Prelub oil press	0
		A		Alarm group	2
		d	t1	Delay (sec)	20
		I		Inhibit	34
		L		Alarm limit	CLOSE
5	7	C1	X8	Upper limit switch	11
		A		Alarm group	0
		d	t3	Delay (sec)	60
		L		Alarm limit	PASS
6	8	C1	X9	Lower limit switch	12
		A		Alarm group	0
		d	t4	Delay (sec)	60
		L		Alarm limit	PASS
8	11	C1	X3	Min. warm up oil temp.	10
		A		Alarm group	0
		L		Alarm limit	PASS
34	25- k7		Z3	Primer pump start outp.	
		t3		Ref. to oil press. opcode	4
		A2		Primer pump start logic	3
20		t1	t2	Cool down timer (min.)	3
12		t1	t7- t2	Max. time to stop (sec)	60
16		F1	x6	Min. DG freq. for running	47.0

### 3.0 WARM-UP LOGIC, DESCRIPTION

When the engine is cold and a startcommand is given, the GCU will first activate the DECREASE output to bring the pilotmotor to the lower position. If the pilotmotor has not reached the lower position within a timedelay of 60 sec. (ref. param "d"), an error message alarm is given. (Error message = 1016). After limitswitch lower position is reached or timeout, the GCU will continue on the starting procedure. The primer pump is given a start signal (ref. opc. 34). At the opcode for the prelubrication oil press (ref. opc. 4), it will be checked for proper oil press before the start procedure is continued. The inhibit (ref.opc.4.I) is set equal to 34, enabling the alarm only in the priming pump starting sequence. The delay (ref.opc.4.d) is set to 20 sec, to let the pump start before checking on the oil pressure. When the oilpressure is acceptable (that is when the digital input on opcode 4 is different from the alarm limit L), the GCU will start the engine. If the oilpressure is not acceptable, the GCU will go to OPERATION BLOCKED, the oil pressure alarmed and a start fail is alarmed.

When the engine has started it will be running on idling rpm untill the input for minimum warm engine is activated (ref.opc.8). When this input is activated, the GCU will activate the INCREASE output to bring the pilotmotor to upper position. If the pilotmotor has not reached the upper position within a timedelay of 60 sec (ref. param "d"), an error message alarm is given. (Error message = 1015). After limitswitch upper position is reached or timeout, the GCU will continue on the synchronize and connecting procedure, if a connect command was given.

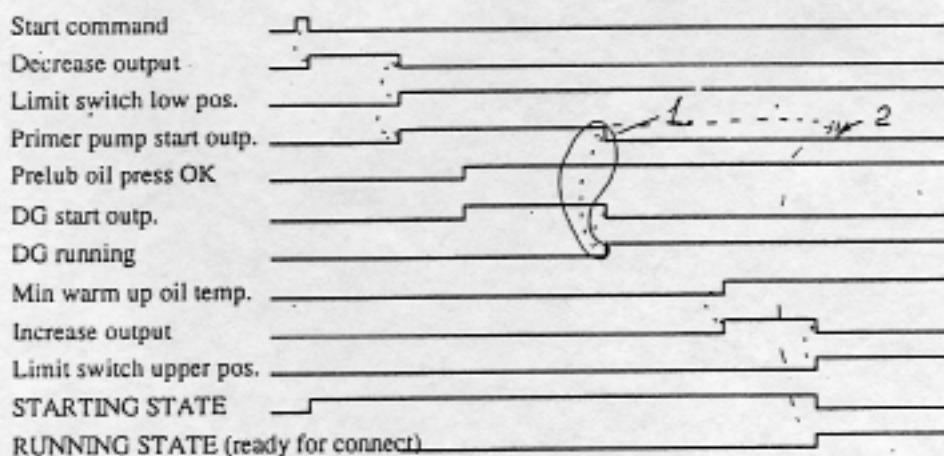
The GCU will block agains sync. & connect as long as the minimum warm engine is NOT active.

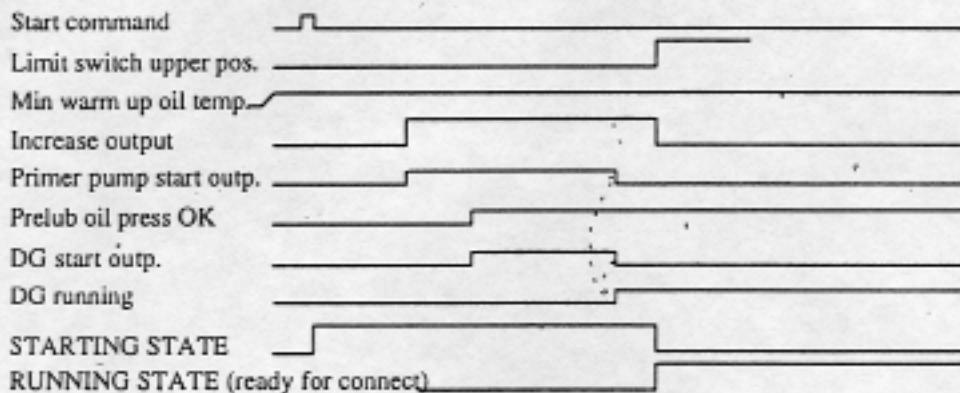
The GCU will indicate STARTING - STATE as long as starting and heating procedure is active. When the pilot-motor has reached the upper position limit switch, running input is active, generator frequency is higher than 47Hz and prelub. oil is warm the GCU will indicate RUNNING - STATE. The dieselegenerator is then ready for connect to the main switchboard.

## 4.0 TIMEDIAGRAMS.

The following timediagrams illustrates a normal starting sequence, for a cold and a warm engine. It is assumed no faults during the starting sequence.

### 4.1 STARTING PROCEDURE WITH COLD ENGINE:

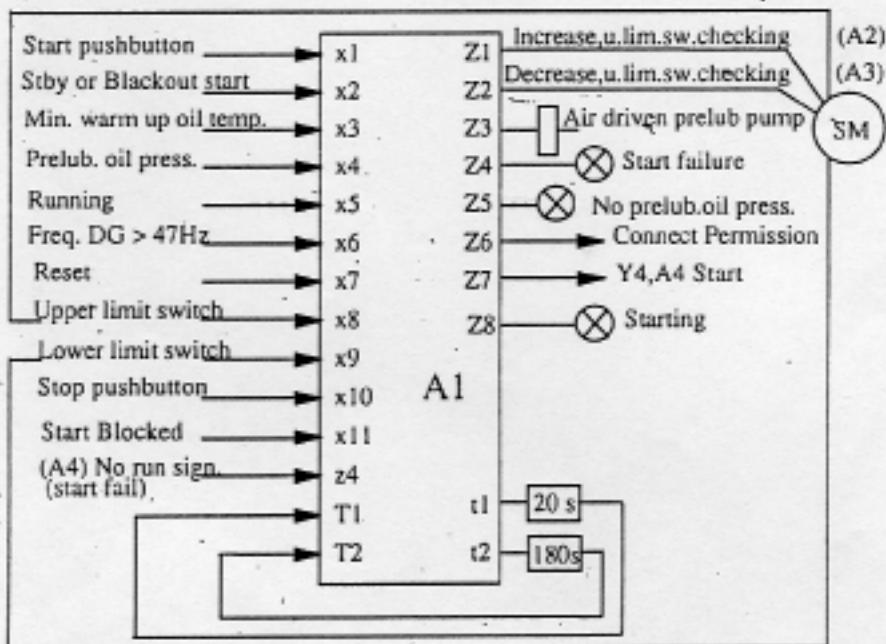


**4.2 STARTING PROCEDURE WITH WARM ENGINE:**

## 5.0 STATUS DIAGRAMS, SPECIFICATION

The Warm-up & Prelubrication logic in the GCU-version 17011CB is based on the following specifications, received from AURORA repr. Mr. Pimenov.

### 5.1 Input/output signal description, Fig.1:



**5.2 Start status diagram A1, Fig.2:**

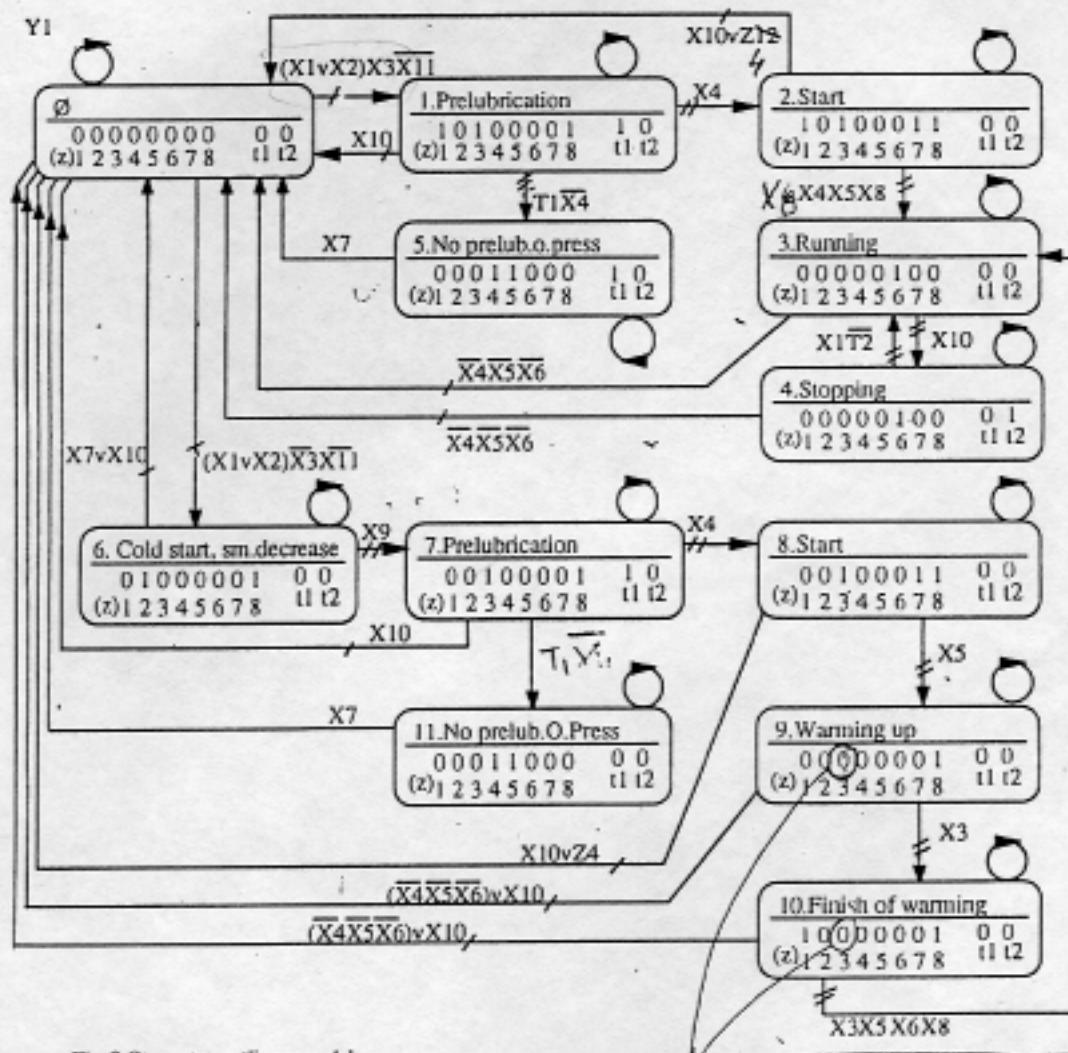


Fig.2 Start status diagram A1

### 5.3 Limit switch checkings, Fig. 3 & 4:

Fig.3.Upper limit switch checking. Input,Output signals description and status diagram A2.

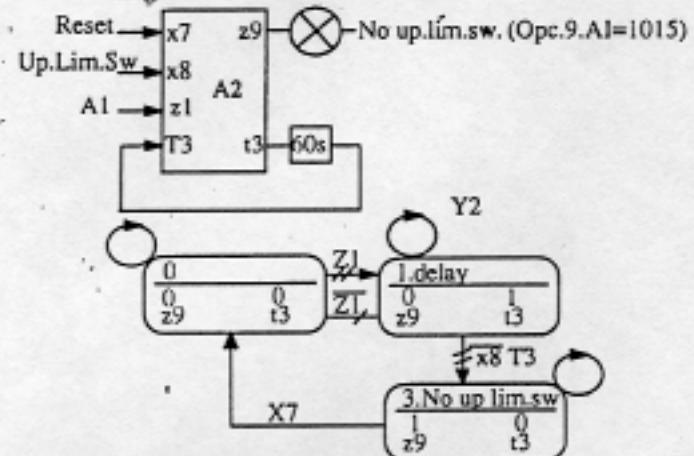
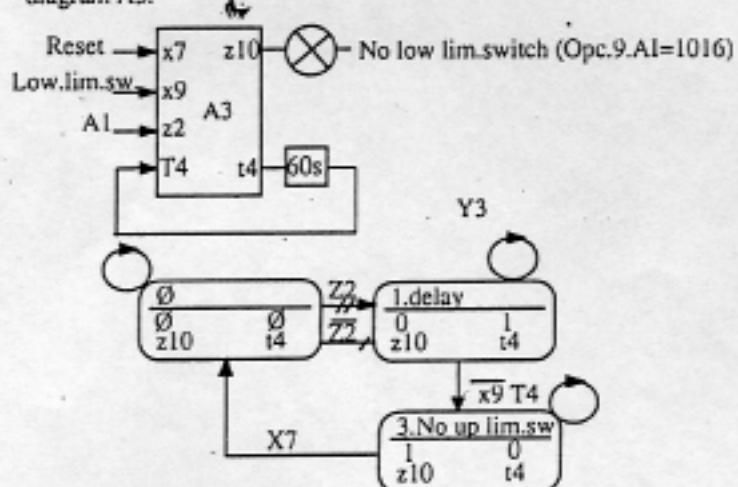


Fig.4. Lower limit switch checking. Input, output signals description and status diagram A3.



### 5.4 Start valve control, A4, Fig.5:

Fig5.Start valve control.input,output signals description and status diagram A4.

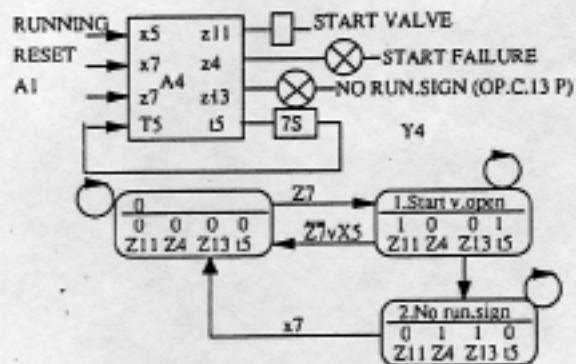
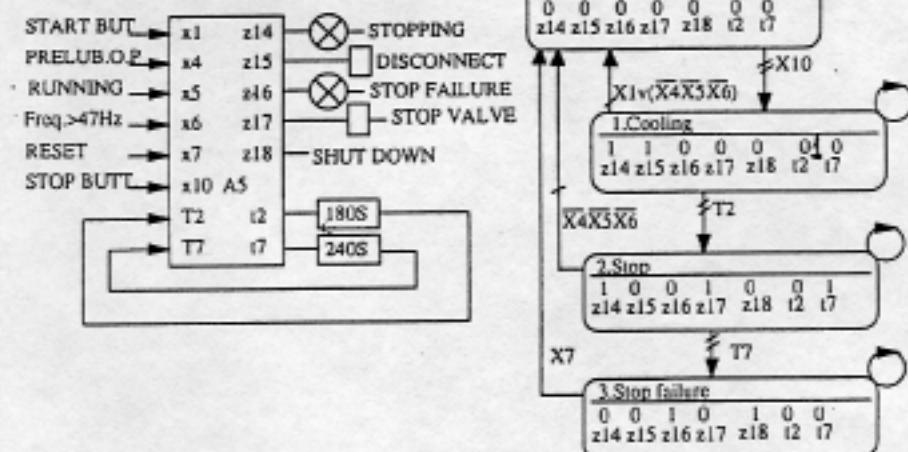


Fig 6.Input/output signals description and stop states diagram A5.



## 6.0 TESTPROCEDURE

### 6.1 STARTING WITH COLD ENGINE

Test the starting sequence by preparing the following:

- The GCU in READY FOR START STATE.
- The GCU in STANDBY-mode.
- The upper and lower limitswitches in "open" position.
- Min. warm-up oil temp in "open" position.
- Prelub. oil press in "ALARM" position (di = alarm limit low).

Push START button and observe that the GCU performs the starting sequence according to the description in section 4.1 and section 5.2, by simulating (at FAT) the inputs or by running in real mode at SAT.

### 6.2 STARTING WITH WARM ENGINE

Test the starting sequence by preparing the following:

- The GCU in READY FOR START STATE.
- The GCU in STANDBY-mode.
- The upper and lower limitswitches in "open" position.
- Min. warm-up oil temp in "closed" position.
- Prelub. oil press in "ALARM" position (di = alarm limit low).

Push START button and observe that the GCU performs the starting sequence according to the description in section 4.2 and section 5.2, by simulating (at FAT) the inputs or by running in real mode at SAT.

### 6.3 STARTING WITH COLD ENGINE without reaching lower lim switch.

Test the starting sequence by preparing the following:

- The GCU in READY FOR START STATE.
- The GCU in STANDBY-mode.
- The upper and lower limitswitches in "open" position.
- Min. warm-up oil temp in "open" position.
- Prelub. oil press in "ALARM" position (di = alarm limit low).

Push START button and observe that the GCU performs the starting sequence according to the description in section 4.1 and section 5.3 Fig. 4, by simulating (at FAT) the inputs or by running in real mode at SAT. Observe specially START FAILURE and ERROR MESSAGE.

### 6.4 STARTING WITH WARM ENGINE without reaching upper lim. switch.

Test the starting sequence by preparing the following:

- The GCU in READY FOR START STATE.
- The GCU in STANDBY-mode.
- The upper and lower limitswitches in "open" position.
- Min. warm-up oil temp in "closed" position.
- Prelub. oil press in "ALARM" position (di = alarm limit low).

Push START button and observe that the GCU performs the starting sequence according to the description in section 4.1 and section 5.3 Fig. 3, by simulating (at FAT) the inputs or by running in real mode at SAT. Observe specially ERROR MESSAGE.