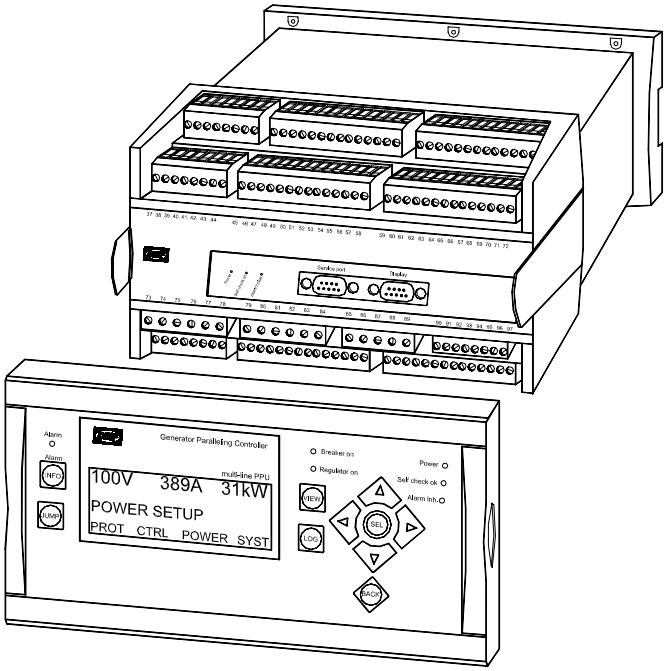
DEIF A/S

Description of options

Option O1
Water turbine control
Multi-line 2 – version 2

4189340286F
SW version 2.4X.X



- *Description of option*
- *Functional description*
- *Parameter list*

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Table of contents

This manual is valid for standard multi-line 2 PPU/GPC units with firmware version 2.32.0 or later.

1. Warnings and legal information

DEIF takes no responsibility for installation or operation of the generator set. If there is any doubt about how to install or operate the generator set controlled by the unit, the company responsible for the installation or the operation of the set must be contacted.

The units are not to be opened by unauthorised personnel. If opened anyway, the warranty will be lost.

Electrostatic discharge awareness

Sufficient care must be taken to protect the terminals against static discharges during the installation. Once the unit is installed and connected, these precautions are no longer necessary.

Safety issues

Installing the unit implies work with dangerous currents and voltages. Therefore, the installation should only be carried out by authorised personnel who understand the risks involved in working with live electrical equipment.

Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.

Definitions

Throughout this document a number of notes and warnings will be presented. To ensure that these are noticed, they will be highlighted in order to separate them from the general text.

Notes

The notes provide general information which will be helpful for the reader to bear in mind.

Warning

The warnings indicate a potentially dangerous situation which could result in death, personal injury or damaged equipment, if certain guidelines are not followed.

2. Description of option

This document contains information about the water turbine control contained in option O1.

Option O1

Function	ANSI no.
3 x 4...20mA inputs with alarms/shutdowns	77
1 x 4...20mA inputs with for indication	77

This option is only available for the GPC and the PPU.

Option O1 can be combined with option M1 or M2.

If the generator is an asynchronous generator then option M1 or M2 must be used at the same time as option O1!

Terminal description

Slot #8, 4-20mA input PCB

Term.	Function	Description
126	Input 5 common	Common
127	Analogue input 5+	4-20mA in for water level control
128	Input 6 common	Common
129	Analogue input 6+	4-20mA in
130	Input 7 common	Common
131	Analogue input 7+	4-20mA in
132	Input 8 common	Common
133	Analogue input 8+	4-20mA in

The 4-20mA input no. 5 must be used for water level input. The 4-20mA inputs no. 6, 7 and 8 can only be used as alarm inputs.

Slot #1, power supply PCB

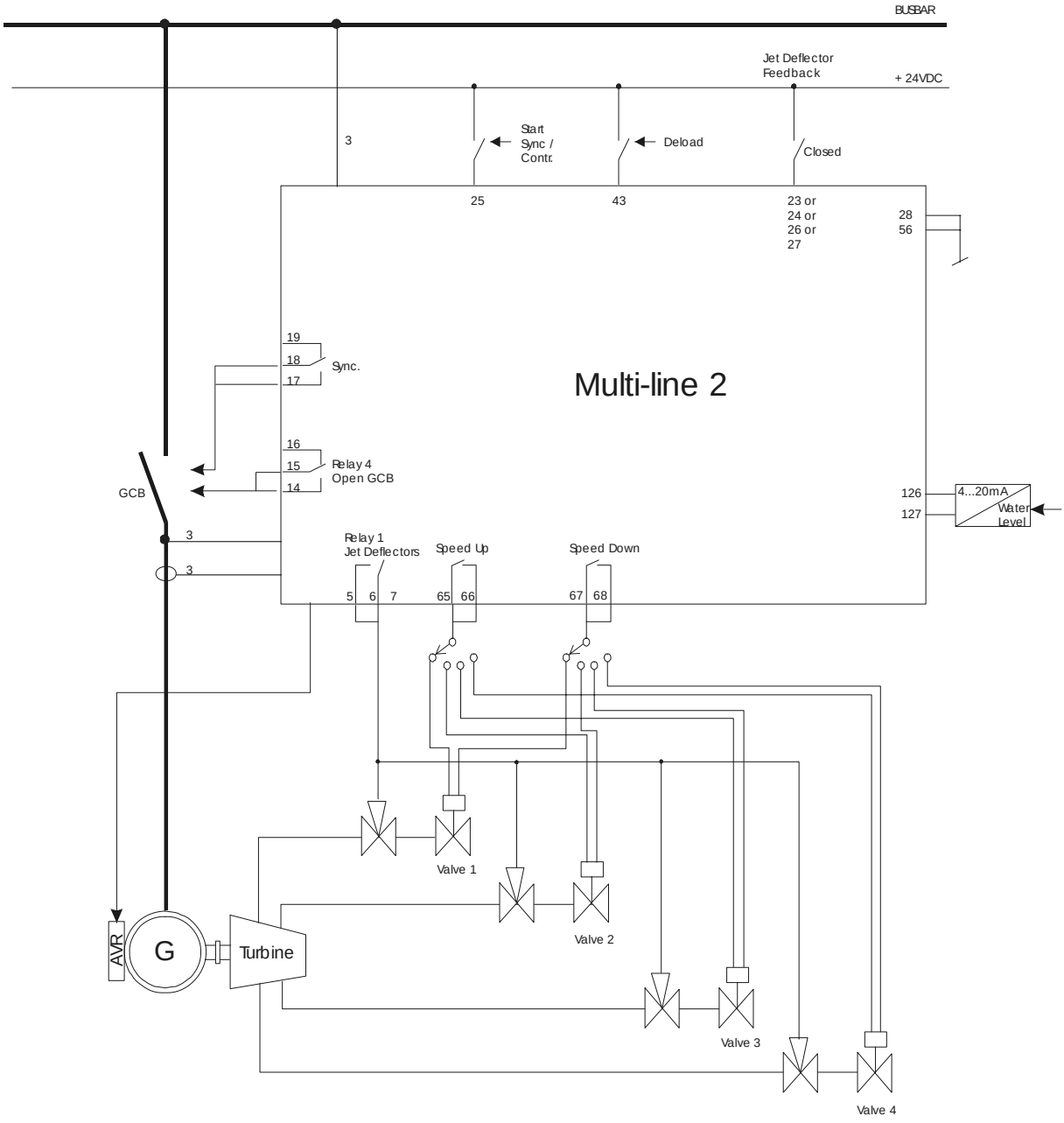
The PCB in slot #1 is installed in all GPC and PPU units. It is shown in this document because the jet deflector relay and feedback is placed on this PCB (terminal 23, 24, 26 or 27).

Term.	Function	Technical data	Description
1	+12/24V DC	12/24V DC -25/+30%	Power supply
2	0V DC		
3	NC	Status relay	Normally closed relay, processor/power supply status supervision
4	Com.	24V / 1A	
5	NO	Relay 1 250V AC / 8A	**Configurable/jet deflector operation**
6	Com.		
7	NC		
8	NO	Relay 2 250V AC / 8A	Configurable
9	Com.		
10	NC		
11	NO	Relay 3 250V AC / 8A	Configurable
12	Com.		
13	NC		
14	NO	Relay 4 250V AC / 8A	Open breaker (deload) Can be configured for tripping also
15	Com.		
16	NC		
17	NO	Relay sync. 250V AC / 8A	Close breaker (synchronising)
18	Com.		
19	NC		
20	Open collector 1	Transistor out	Pulse output 1, kWh counter
21	Open collector 2	Transistor out	Pulse output 2, kvarh counter
22	Com.	Common	Common terminal for terminals 20 and 21
23	Binary input	Optocoupler	Remote alarm inhibit/**configurable**
24	Binary input	Optocoupler	Remote alarm acknowledge/**configurable**
25	Binary input	Optocoupler	Start sync./control functions/configurable
26	Binary input	Optocoupler	Ext. communication control/**configurable**
27	Binary input	Optocoupler	Block loss of mains/**configurable**
28	Com.	Common	Common for terminals 23-27

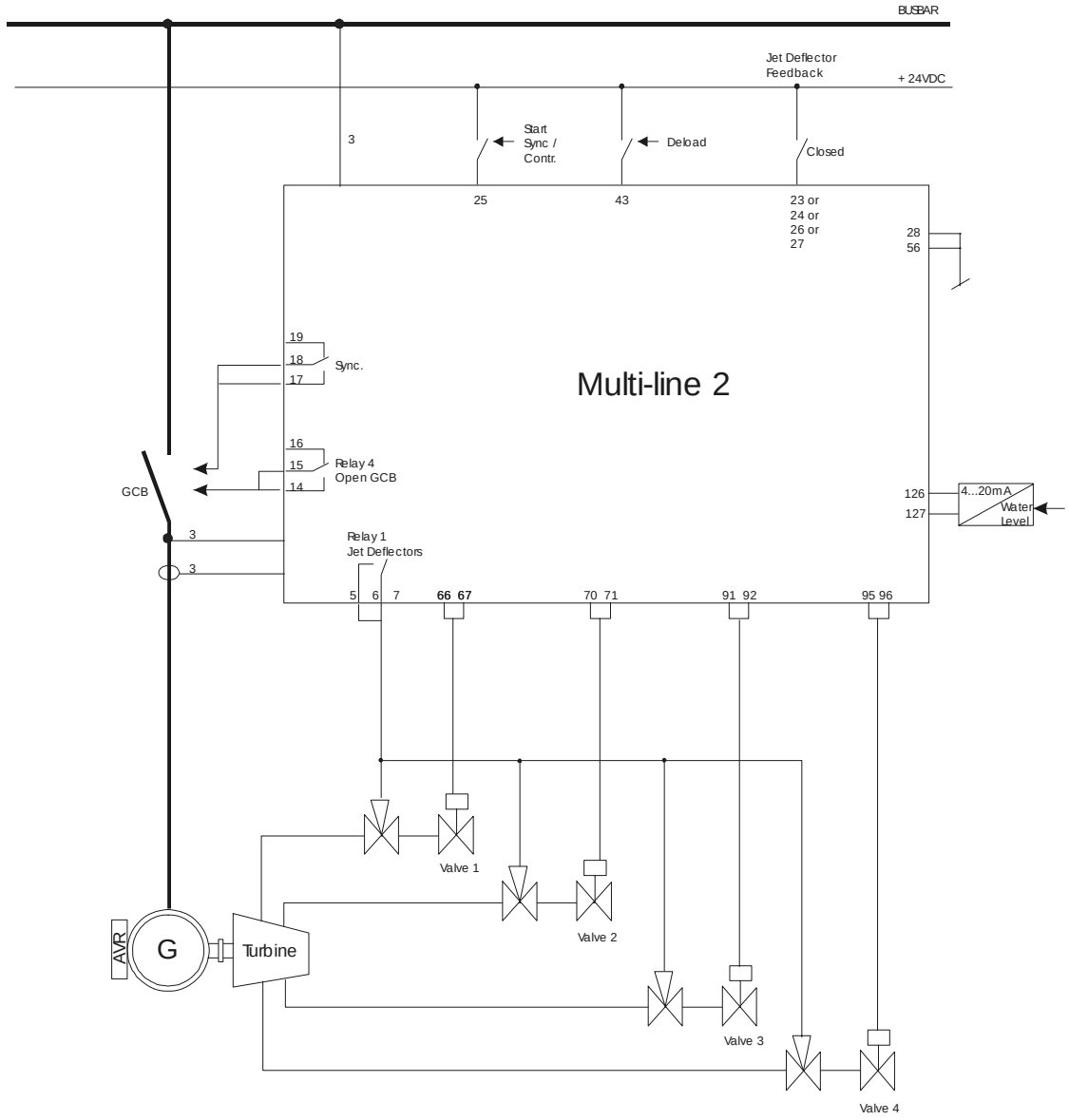
Terminal 25 cannot be used for jet deflector feedback.

Wiring

Relay output turbine valve control



Analogue output turbine valve control



3. Functional description

Option O1 contains three main functions.

1. Water level control
2. Jet deflector control
3. Modified regulation

These functions can be used in a combination or separately.

Water level control requires a 4-20mA transducer.

Turbine operation

The turbine can be controlled by the multi-line 2 in five different ways. This depends on the mode selection on the unit. The table shows the running modes depending on the mode setting.

Mode inp. / Running mode	Mode 1 Terminal 48	Mode 2 Terminal 49	Comment
Fixed frequency	OFF	OFF	
Fixed power	ON	OFF	Menu 4131 must be OFF
Droop	OFF	ON	
Load sharing	ON	ON	
Fixed water level control	ON	OFF	Menu 4131 must be ON

A further description of the general running modes can be found in the Designer's Reference Handbook.

Water level regulation

The water level regulation must be used if the regulation depends on the water level in the reservoir which contains the water that drives the turbine.

Activate water level control

To activate the water level regulation, the mode input 1 must be activated and the menu 4131 must be adjusted to ON (see the table above).

Transducer setup

The 4-20mA transducer must be connected to terminals 126/127 (see the I/O list above). The setup is done in the system setup as well as in the input setup.

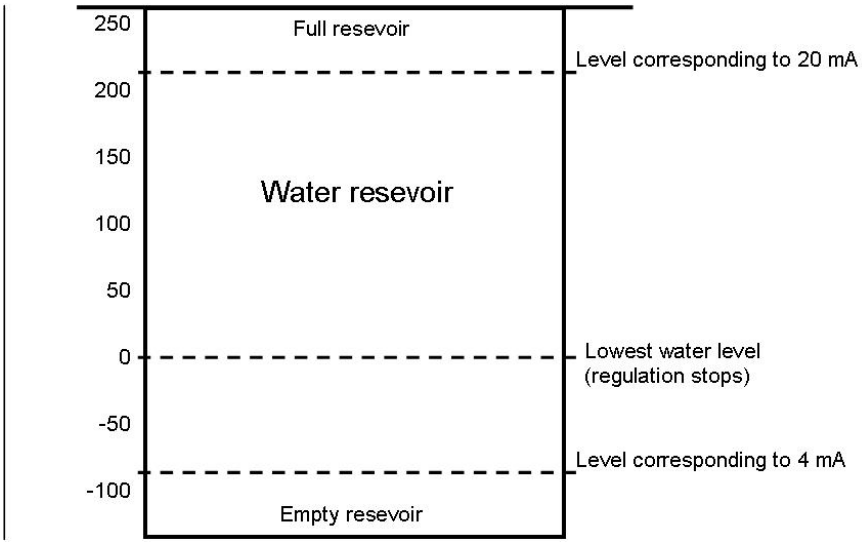
System setup

The values corresponding to 4mA and 20mA must be adjusted in the menus 4042 and 4043.

Menu	Description	Comments
404X	Water level nominal	This value corresponds to the 20mA value of the transducer.
404X	Water level minimum	This value corresponds to the 4mA value of the transducer.

This can be adjusted from the USW or from the display.

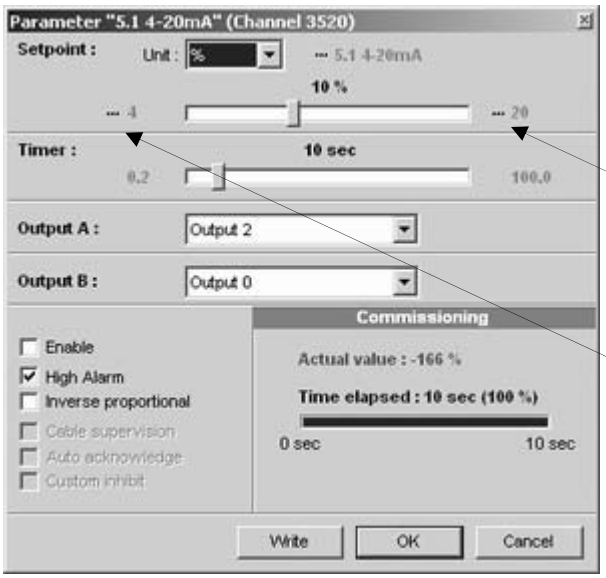
The 4mA value can be adjusted negative. This is to be able to stop the regulation (see the description of 'Water level regulation' on page 10).



Input setup

The scaling of the transducer can be adjusted in the input setup, menu 3520.

This can only be adjusted from the USW.



Adjust the water level corresponding to the 20mA value.

Adjust the water level corresponding to the 4mA value.

The input can only be scaled in percent.

If the scaling is not done according to the specific application, the regulation will work but the display reading will be false.

Regulation principle

Principle

When the regulation is started, the multi-line 2 will regulate the power according to the water level and the fixed power set point.

The below drawing illustrates how the regulation works:

1. The power set point is set to 90% (menu 4041).
2. The water level transducer gives 20mA when the water level is above 180% (menu 404X).
3. The water level transducer gives 4mA when the water level is below -60% (menu 404X).

When the turbine is running and the regulation is activated, the power of the gen-set will depend on the available water level.

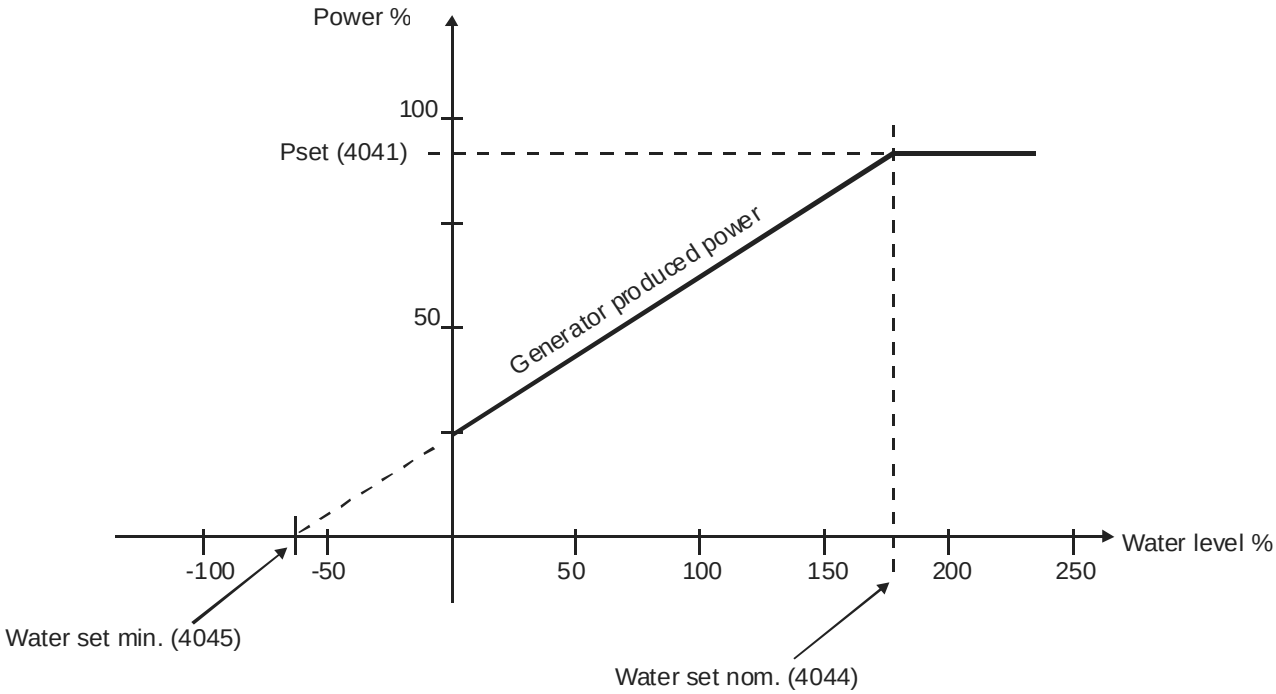
Water level above normal

When there is plenty of water in the reservoir, the transducer will give 20mA output. This means that the power of the gen-set will be maintained at the P_{SET} (menu 4041).

Water level below normal

Because the water level is below normal level, the power of the gen-set will be decreased according to the slope of the transducer curve that is adjusted in the menu 404X/404X. In the drawing below, the power will be adjusted from the set point 'P_{SET}' (menu 4041) and downwards to 25%.

The regulation stops when the percentage of the water level goes negative. In this example this means that the minimum output from the turbine is 25%.



Before the GPC/PPU enters the water level control it will go into the ramp up sequence using the settings in menus 2141 and 2142.

Operating range

The operating range of the turbine can be reduced in the lower end by adjusting the 4mA value to a negative value. The power will not be regulated into the area where the water level is negative. (The purpose of this is partly to avoid the generator to go into reverse power and partly to keep the turbine in the economic operating range.)

The operating range of the turbine can be reduced in the high end by decreasing the P_{SET} (menu 4041) to a lower value.

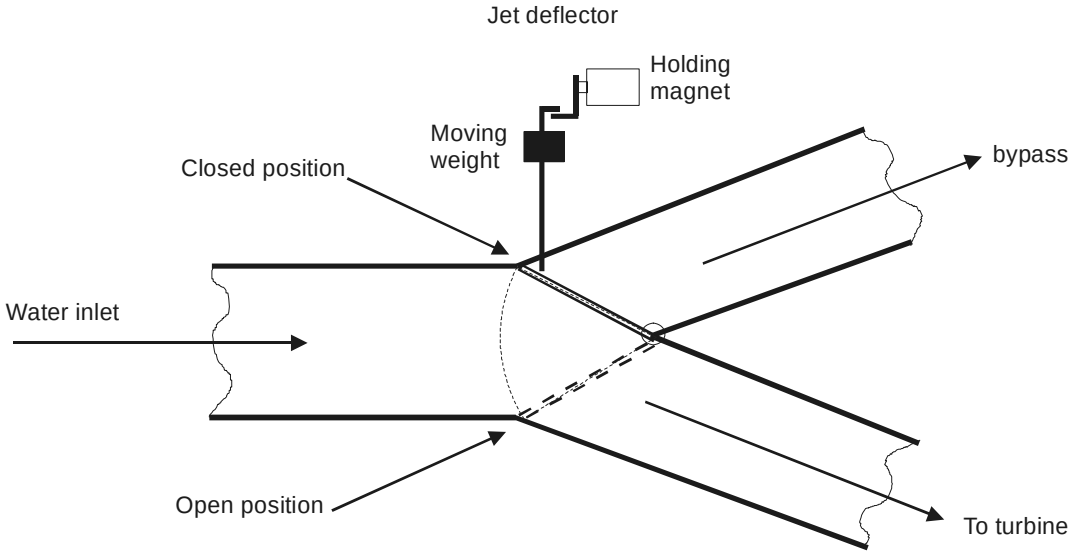
Jet deflector

In principle, the jet deflector is a 3-way valve intended to bypass the water flow in case there is a generator shutdown.

Principle

Normally, the jet deflector is 'closed' (water flow led to the turbine) and held closed by a holding magnet. In case of shutdown, the jet deflector magnet is deactivated, and the jet deflector immediately changes to 'open' (water bypass) position.

The principle looks like this (jet deflector shown in 'closed' position):



If the jet deflector is moved to the 'open' position, it must be set back to 'closed' position manually.

Use the jet deflector feedback to indicate when the deflector is closed.

Relay selection

The relay used for the jet deflector is the relay 1. (Terminal 5, 6, 7 - see extract from I/O list below).

Term.	Function	Technical data	Description
5	NO	Relay 1 250V AC / 8A	**Configurable/jet deflector operation**
6	Com.		
7	NC		

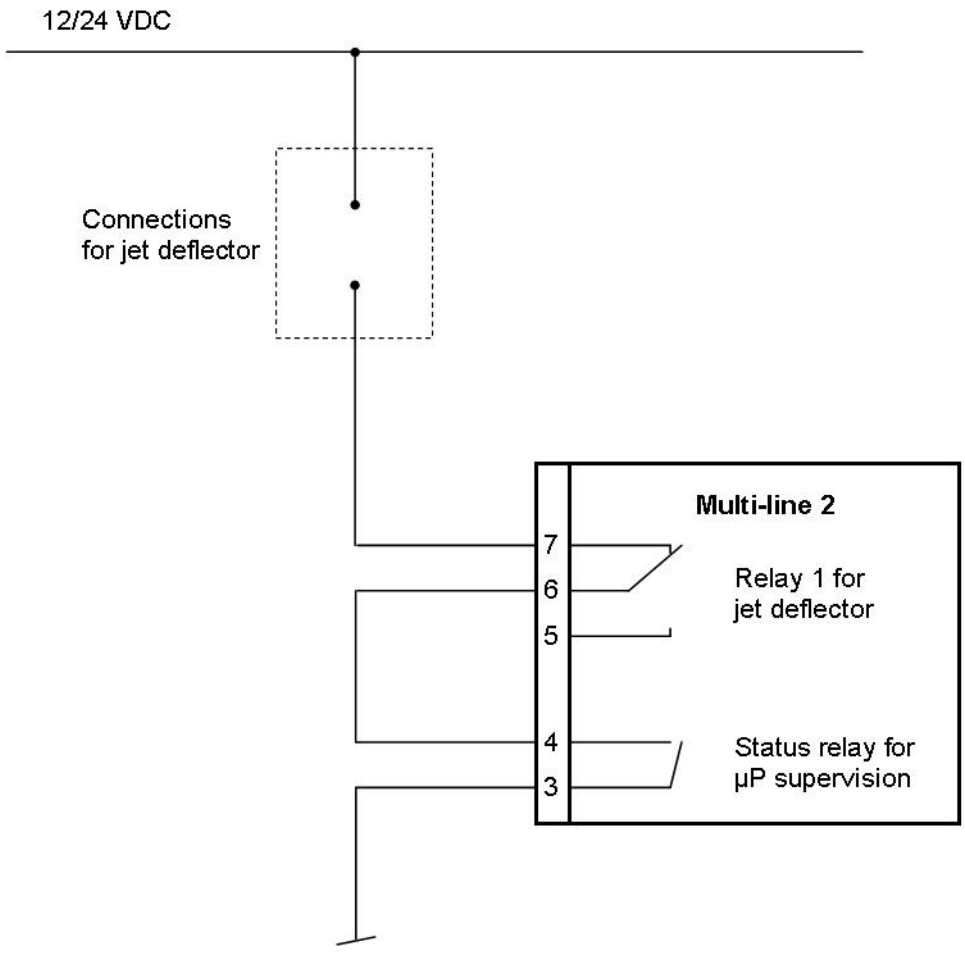
Relay functionality

The relay output for the jet deflector will either open the jet deflector or keep it in the closed position. When the deflector must open, relay 1 will change position to 5/6, thus disconnecting the current flow through 6/7.

The purpose of using the status relay is to open the deflector whenever the multi-line 2 is without power or when the watch dog of the device detects a fault.

When the multi-line 2 is without power, relay 1 output will be in the 'closed' deflector valve position.

To open the deflector valve, use the status relay or open it by other means.



The status relay is a normally closed relay. When the GPC/PPU is in good functioning condition the relay is energized.

The status relay is only for DC voltage.

The multi-line 2 will hold the deflector valve closed except in shutdown situations.

Turbine regulation

Relay controls

Because the regulation of bigger water turbines is relatively slow, some maximum regulation settings are increased:

- Maximum synchronisation failure timer (menu 2061) is increased to 3000.0 s.
- Relay output period time (menu 2252) is increased to 32500 ms.

Analogue controls

The analogue output(s) can handle up to 4 analogue outputs for control valves and/or voltage regulator. This is adjusted in the menu 4950.

The output combinations are shown in the table:

Function / Output	Option D1 NOT selected		Option D1 selected	
	Cascade	**Voltage control**	**Cascade**	**Voltage control**
Output 66/67	**X**	**Not available**	**X**	
Output 70/71	**X**			**X**
Output 91/92	**X**		**X**	
Output 95/96	**X**		**X**	

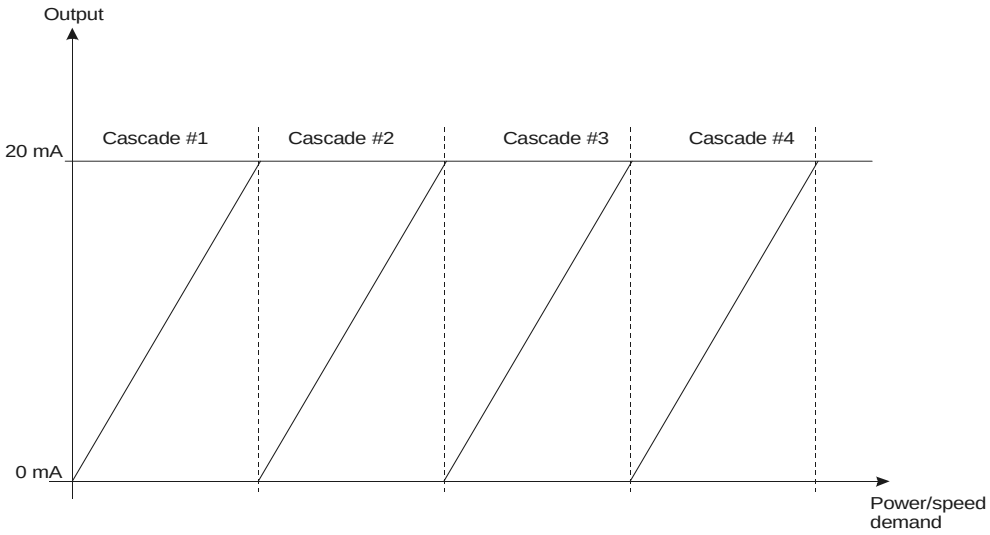
Analogue control valves, parallel w. mains generator

If analogue outputs are needed, then order option E1 for two analogue outputs and option E1 + F1 for 4 analogue outputs in total.

The cascade works like this:

At turbine start, all outputs are 0mA. As the speed/load set point increases, the cascade #1 will give increasing signal until reaching 20mA. At this point, cascade #2 will take over and increase its output until 20mA, and so on. When the turbine is stopped the sequence is reversed.

The output sequence looks like this in a situation where all cascades open:

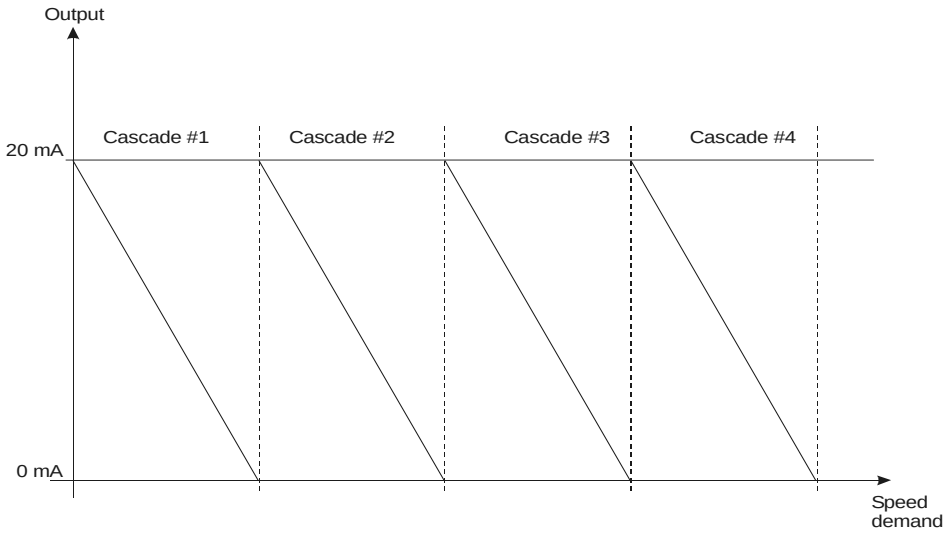


There can be up to 4 analogue outputs for cascade control of valves.

Analogue control, stand-alone generator with load control

If the generator is a stand-alone (typical for micro synchronous water turbines), the RPM is often controlled with variable loads (thyristor controlled resistive loads).

In this case, the analogue outputs can be inverted so that the analogue output will decrease in case an increased RPM is needed. In this case, the output curves look like this:



There can be up to 4 analogue outputs for cascade control of loads.

Sequences

Turbine start

Due to the slow start-up of a turbine, the function in menu 2255 ‘Turbine start timer’ has been added. The turbine start function can be used in connection with relay outputs only.

This timer represents the time where the speed UP signal is active if no speed is detected during start-up of the turbine. (Running detection is the frequency measurement or pick-up tacho input).

Pick-up input is only available when option M1 or M2 is selected.

When the timer expires, the speed UP signal deactivates and the GPC/PPU awaits the running feedback before it resumes regulating.

The UP signal is deactivated after a specific time to prevent overspeeding of the turbine.

The timer setting must be found during the commissioning.

The timer can be adjusted to zero (factory setting) if this function is not required.

Start sequence

The start sequence consists of 4 steps:

1. Deflector valve(s) closed feedback ON
2. Open control valve 1, synchronising
3. Breaker closes
4. Power (and possibly power factor) control for parallel w. mains or frequency control for island

Stop sequence

The stop sequence consists of three steps:

1. Ramp down generator to load 0 kW
2. Open breaker
3. Close all control valve(s)

Shutdown sequence

The shutdown sequence consists of three steps:

1. Generator breaker trip
2. Jet deflector open (bypass water flow)
3. Shut control valves

Digital Input

The inputs can be configured in the PC utility software. The following function is special for option O1.

Terminal	Input function	Input type Const./Pulse
23, 24, 26, 27	Jet deflector	

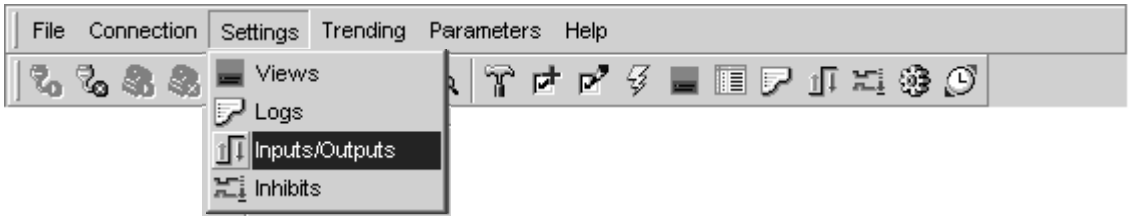
Functional description

Jet deflector

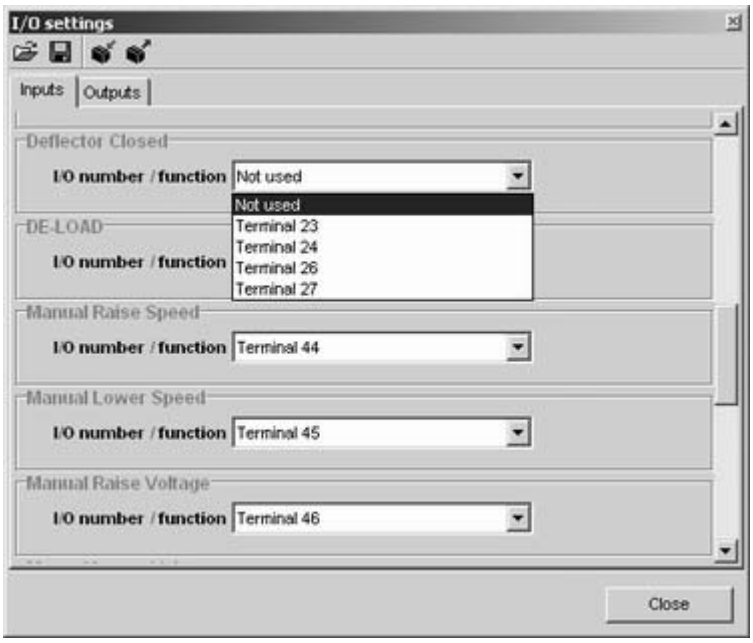
The jet deflector input is used when the GPC/PPU controls the opening of the jet deflector.

Configuration

The input functions are activated using a binary input. The input must be chosen in the PC utility software. (Select the menu 'Settings'/'Inputs/Outputs' or press the icon on the horizontal toolbar).



When selecting 'Inputs/Outputs', this dialog box appears:



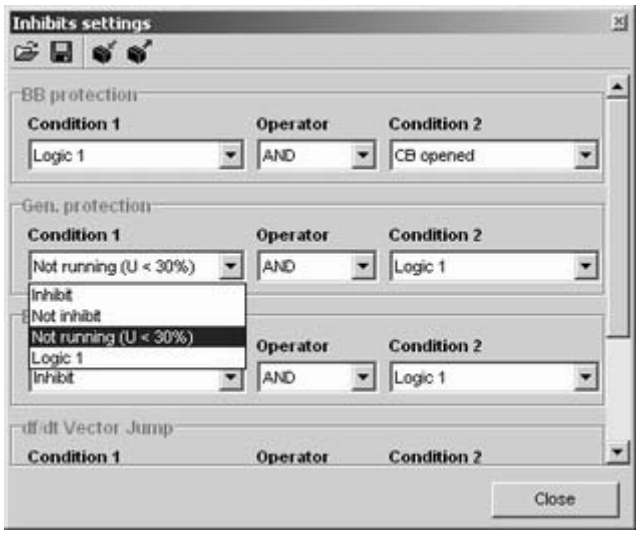
In the example of the configuration above, the 'Deflector closed' feedback can be changed to terminals 23, 24, 26 or 27.

Inhibit

The inhibit functionality is described in the Designer's Reference Handbook. The functionality varies if the inhibit has been configured manually through the configuration tool in the USW.

Not running

When the protections are configured to 'Not running', then the alarms are activated when the frequency measurement is $f_{NOMINAL}$ –1Hz, typically 49Hz or 59Hz.



When stopping the turbine, the alarms will not be deactivated before the generator voltage has dropped to 30 % * $U_{NOMINAL}$.

4. Parameter list

2250 Turbine start

No.	Setting		Min. setting	Max. setting	Factory setting
2255	Turbine start timer	Time	0 s	100 s	0 s

3520 4-20mA in. no 5.1

No.	Setting		Min. setting	Max. setting	Factory setting
3521	4-20mA in no. 5.1	Set point	0.0%	250.0%	10.0%
3522	4-20mA in no. 5.1	Time	0.2 s	100.0 s	10.0 s
3523	4-20mA in no. 5.1	Relay output A	R0 (none)	Option dependent	R2
3524	4-20mA in no. 5.1	Relay output B	R0 (none)		R0
3525	4-20mA in no. 5.1	Enable	OFF	ON	OFF

3530 4-20mA in. no 5.2

No.	Setting		Min. setting	Max. setting	Factory setting
3531	4-20mA in no. 5.2	Set point	0.0%	250.0%	10%
3532	4-20mA in no. 5.2	Time	0.2 s	100.0 s	10.0 s
3533	4-20mA in no. 5.2	Relay output A	R0 (none)	Option dependent	R2
3534	4-20mA in no. 5.2	Relay output B	R0 (none)		R0
3535	4-20mA in no. 5.2	Enable	OFF	ON	OFF

4040 Power settings

No.	Setting		Min. setting	Max. setting	Factory setting
4041	Controller settings P	Fixed power set point	0%	100%	100%
4042	Controller settings var	Fixed var set point	0%	100%	30%
4043	Controller settings PF	Fixed PF set point	0.60	1.00	0.90
4044	Controller settings W	Water level nominal	0%	250%	100%
4045	Controller settings Wmin	Water level min.	-100%	250%	0%

4130 Water level indication

No.	Setting		Min. setting	Max. setting	Factory setting
4131	Water level in.	Enable	OFF	ON	OFF

DEIF A/S reserves the right to change any of the above