DEIF
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Generator Protection Unit, GPU-3
APPLICATION NOTES

Genset control and protection with safety system

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1. About this document

This document includes application notes for DEIF's Generator Protection Unit, the GPU-3. It mainly includes engine control and protection instructions and functional description.

The general purpose of this document is to give the user important information to be used in the installation of GPU-3 controllers.

Intended users

The Application Notes is mainly intended for the panel builder designer in charge. On the basis of this document, the panel builder designer will give the electrician the information he needs in order to install the GPU-3 controllers, e.g. detailed electrical drawings. In some cases the electrician may use this instruction himself.

Contents/overall structure

This document is divided into chapters, and in order to make the structure simple and easy to use, each chapter will begin from the top of a new page.

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.

Warnings

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

2. Warnings and legal information

Legal information and responsibility

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

> **The system 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 system is installed and connected, these precautions are no longer necessary.

Safety issues

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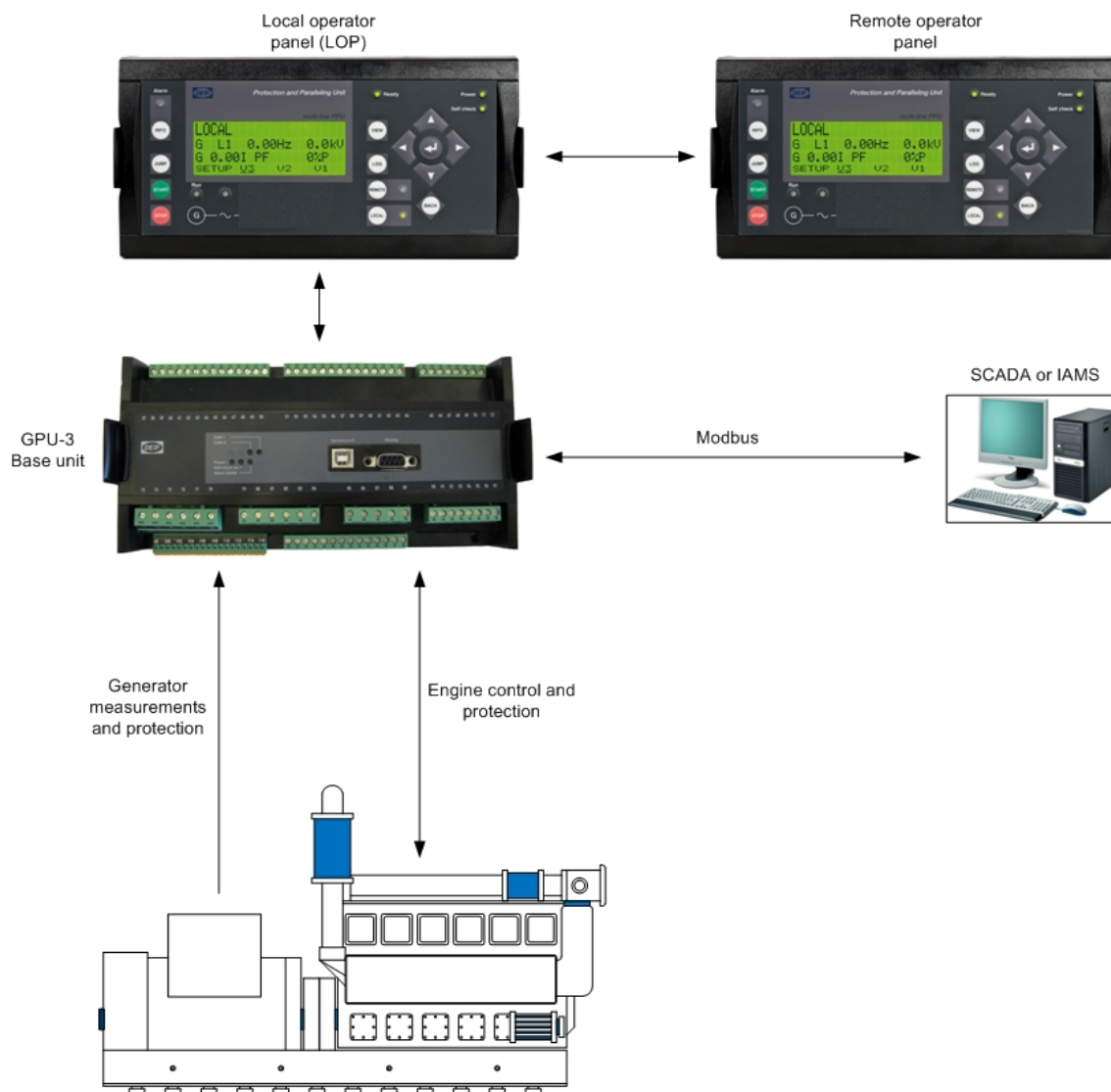
> ⚠ **Be aware of the hazardous live currents and voltages. Do not touch any AC measurement inputs as this could lead to injury or death.**

3. Application description

System overview

This document describes the HW, wiring and setup required to make a marine genset control and protection system including safety system for engine protection.

The system will have the following functionalities:

1. Engine start/stop
2. Engine protection
3. Safety system for engine protection
4. Indication of engine and generator measurements
5. Generator protection
6. Local and remote operator panel
7. Modbus interface to Alarm and Monitoring System (AMS)

Required hardware

To support this application, the following hardware is required.

GPU-3 unit with display and the following options:

- Option H2 (Modbus communication)
- Option M4 (engine control and protection)
- Option M15.6 (4x 4-20 mA inputs)
- Option X2 (additional display unit)
- Option Y7 (display layout with engine control)

Please refer to www.deif.com for a complete list of available options.

4. Functional description

Engine control

It is possible to control the genset locally from the display or remotely by means of either digital inputs or Modbus communication.

Local control

Local control is selected by pressing the Local push-button on the display. In local operation, start and stop of the engine is controlled from the display.

Remote control

Remote control is selected by pressing the Remote push-button on the display. In remote operation, the start/stop push-buttons are inactive and control is handled remotely by means of:

- Digital inputs (remote start/stop)
- Modbus commands (remote start/stop)

This makes it possible to control the engine from push-buttons in the main switchboard as well as from the Alarm and Monitoring System (AMS).

Engine data and protection

Alarms and shutdowns

The following engine data and protection are supported in this application:

Measurement	Input type	Local indication	Wire break	Alarm	Shutdown
Lube oil pressure	Switch and 4-20 mA	X	X	Low	Low
Lube oil temp.	4-20 mA	X	X	High	
Coolant temp.	Switch and 4-20 mA	X	X	High	High
Coolant pressure	4-20 mA	X	X	Low	
Speed (rpm)	MPU and f_{GEN}	X	X	High	High

Remote indication

Remote indication of engine data and alarms is achieved by the additional display unit which can be mounted in the engine control room or on the bridge, dependent on requirements.

Stop coil

The stop coil circuit is provided with a wire break supervision which monitors the stop coil output when it is not activated.

Running feedback

Under normal circumstances, the running feedback will be based on the speed signal from the magnetic pick-up. In case of lost running feedback during operation, a running feedback failure will be activated, and the operation will be maintained using the AC frequency measurement as backup running feedback.

Shutdown override

When the shutdown override input is activated, only the emergency stop and overspeed protection is active.

Safety system

The unit contains two independent systems for fail-safe operation of control- and safety functions.

In case of failure on any of the two independent systems, the vital engine protections will still be maintained since both systems have an independent processor and power supply.

Main processor failure

In case of a power supply or processor failure, the status output relay (term. 3-4) will open. The backup system (M4 board) detects the failure by loss of communication to the main processor, but it remains active in the sense that all the protective functions are operating. No relay output activities will appear on the backup system due to the main processor failure.

A power supply failure in the main unit will also activate the backup system.

Failure of the engine control and protection system (option M4)

In case of a power supply or processor failure, an 'Int. comm. fail' alarm will be activated by the main processor. The 'Int. comm. fail' alarm can be configured to activate an alarm relay for indication of failure at the safety system. All activated relays on the M4 board will reset, but since a stop coil is used, the engine will keep running. The engine protection will be handled by the main processor based on the analogue values for oil pressure and coolant temperature and the AC frequency measurement.

(i) **Special attention must be given to the individual marine classification society rules and requirements for installation of safety systems; e.g. in regard to automatic change-over from normal to stand-by power supply including audible and visual alarm.**

Generator data and protection

The most common generator data is available in the display, and additional information can be added with the PC utility SW.

The unit contains a wide range of generator and busbar protections. The required protections depend on the specific application and the requirements from the classification society.
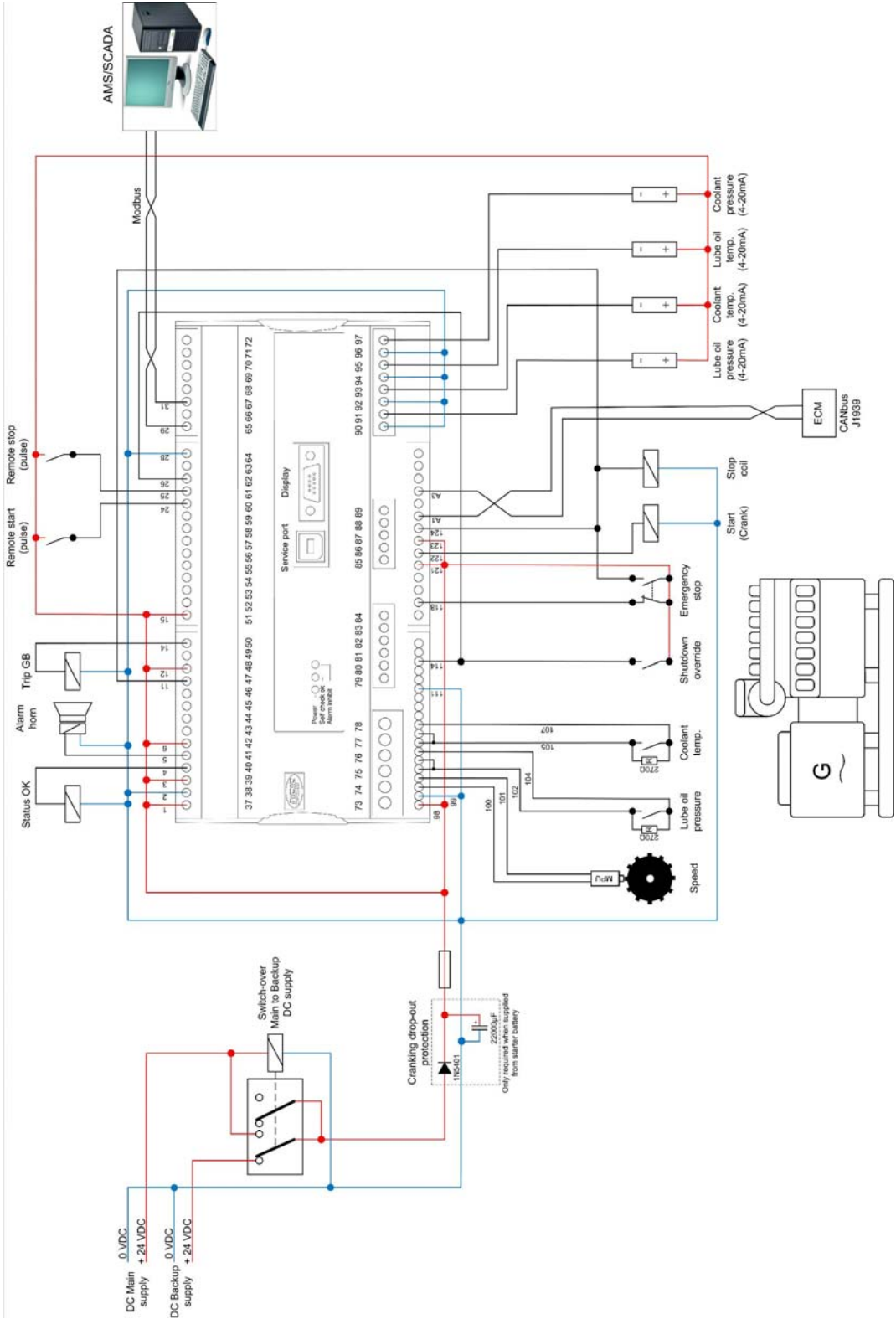
Modbus interface

The Modbus interface is typically used for remote control and monitoring, e.g. from the ship's alarm and monitoring system.
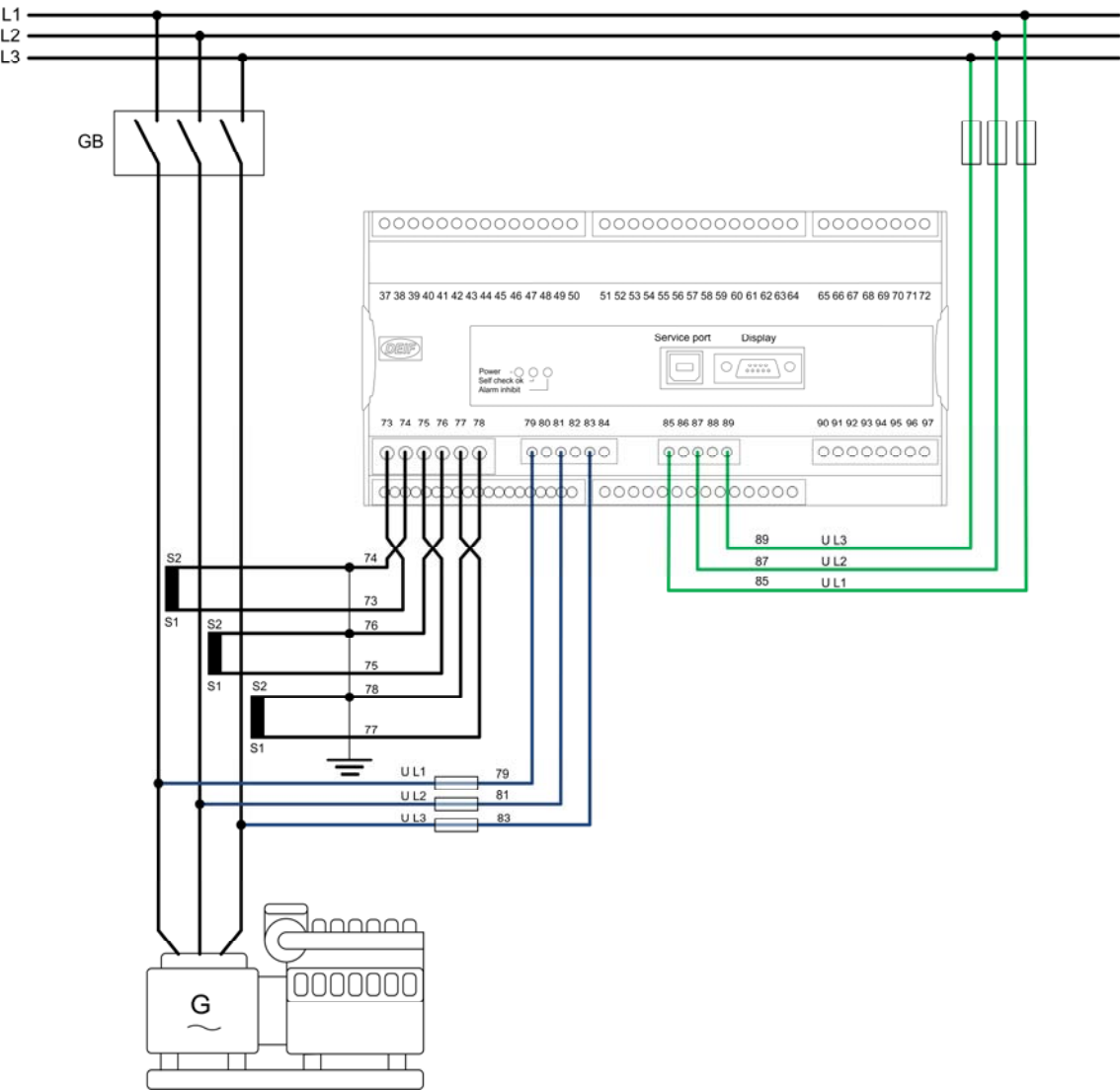
(i) **Please refer to the document "Description of Option H2 and H9" for further information regarding the Modbus interface and protocol.**

5. DC wiring

6. AC wiring

7. I/O lists

Slot #1, power supply and digital I/Os (standard)

Term.	Function	Technical data	Description
1	+12/24V DC	8-36V DC	Power supply
2	0V DC		
3	NC	Status relay	Normally closed relay, processor/power supply
4	Com.	24 V/1 A	status supervision
5	NO	Relay 5	Alarm horn
6	Com.	250V AC/8 A	
7	NC		
8	NO	Relay 8	Configurable
9	Com.	250V AC/8 A	
10	NC		
11	NO	Relay 11	Shutdown (stop coil)
12	Com.	250V AC/8 A	
13	NC		
14	NO	Relay 14	Open GB
15	Com.	250V AC/8 A	
16	NC		
17	NO	Relay 17	Configurable
18	Com.	250V AC/8 A	
19	NC		
20	Open collector 1	Transistor out (relay 20)	Configurable
21	Open collector 2	Transistor out (relay 21)	Configurable
22	Com.	Common	Common terminal for terminals 20 and 21
23	Digital input	Optocoupler	Configurable
24	Digital input	Optocoupler	Remote start (pulse signal)
25	Digital input	Optocoupler	Remote stop (pulse signal)
26	Digital input	Optocoupler	Configurable
27	Digital input	Optocoupler	Configurable
28	Com.	Common	Common for digital input 23 to 27

Slot #2, Modbus communication (option H2)

Term.	Function	Technical data	Description
29	DATA + (A)	Modbus RS485, RTU or ASCII	Serial communication line to Integrated Alarm and Monitoring System (IAMS)
30	*Not used*		
31	DATA – (B)		
32	*Not used*		
33	DATA + (A)		
34	*Not used*		
35	DATA – (B)		
36	*Not used*		

Slot #5, AC measuring (standard)

Term.	Function	Technical data	Description
73	I L1 s1	1/5A AC input	Generator current L1
74	I L1 s2		
75	I L2 s1	1/5A AC input	Generator current L2
76	I L2 s2		
77	I L3 s1	1/5A AC input	Generator current L3
78	I L3 s2		
79	U L1	Max. 690V AC phase-phase value	Generator voltage L1
80	*Not used*		
81	U L2	Max. 690V AC phase-phase value	Generator voltage L2
82	*Not used*		
83	U L3	Max. 690V AC phase-phase value	Generator voltage L3
84	U neutral		Generator voltage neutral
85	U BB L1	Max. 690V AC phase-phase value	Busbar voltage L1
86	*Not used*		
87	U BB L2	Max. 690V AC phase-phase value	Busbar voltage L2
88	U neutral		Busbar voltage neutral
89	U BB L3	Max. 690V AC phase-phase value	Busbar voltage L3

Slot #8, analogue inputs (option M15.6)

Term.	Function	Technical data	Description
90	Input 91 common	0(4)…20 mA Impedance: 50 Ω	Lube oil pressure
91	Analogue input 91 +		
92	Input 93 common	0(4)…20 mA Impedance: 50 Ω	Coolant temperature
93	Analogue input 93 +		
94	Input 95 common	0(4)…20 mA Impedance: 50 Ω	Lube oil temperature
95	Analogue input 95 +		
96	Input 97 common	0(4)…20mA Impedance: 50Ω	Coolant pressure
97	Analogue input 97 +		

Slot #7, engine interface board (option M4)

Term.	Function	Technical data	Description
98	+12/24V DC	8-36V DC	DC power supply
99	0V DC		
100	MPU input	0.5-70V AC/	Magnetic pick-up input for RPM indication
101	MPU GND	10-10000 Hz	and overspeed (shutdown)
102	A		Low lube oil pressure switch (shutdown)
103	B		
104	C	0(4)-20 mA	
105	A	Digital	High coolant temp. switch (shutdown)
106	B	Pt100	
107	C	Pt1000	
108	A	VDO	Configurable
109	B	0-40V DC	
110	C		
111	Common		Common for digital input 112 to 117
112	Digital input 112	Optocoupler	Configurable
113	Digital input 113	Optocoupler	Configurable
114	Digital input 114	Optocoupler	Shutdown override
115	Digital input 115	Optocoupler	Configurable
116	Digital input 116	Optocoupler	Configurable
117	Digital input 117	Optocoupler	Configurable
118	Digital input 118	Optocoupler	Emergency stop (NC) and common for 119 and 120
119	NO	Relay 24V DC/5 A	Run coil - not used
120	NO	Relay 24V DC/5 A	Start prepare
121	Com.	Relay 24V DC/5 A	Crank (starter)
122	NO		
123	Com.	Relay 24V DC/5 A	Stop coil w/wire break
124	NO		
A1	NA	NA	NA
A2	NA		
A3	NA		
B1	CAN-H	CANbus interface	Option H7 - J1939 engine interface
B2	CAN GND		
B3	CAN-L		

To avoid faulty activation of the stop coil caused by the wire break circuit, use a stop coil with the following specifications:
24V DC: I_{ON}>10mA/R_{COIL}<1650 Ω - 12V DC: I_{ON}>10mA/R_{COIL}<800 Ω.

8. Basic utility software setup

General

This chapter describes the minimum requirements for setup to achieve the functionalities mentioned in the chapter 'Functional description'.

This unit uses the PC utility software version 3 (USW 3) which can be downloaded free of charge at www.deif.com.

> **For further details on how to set up the unit, please refer to the documents 'Quick Start Guide' and 'General Guidelines for Commissioning'.**

Parameters

The following parameters have to be adjusted for this application.

Parameter no.	Function	Recommended settings				
		Setpoint	**Delay**	**Enable**	**Fail class**	**Inhibits**
1220 G f> 2	Generator over-frequency protection	115%	1.0 s	ON	Shutdown	
3400 Dig. input 102	Lube oil pressure low switch		1.0 s	ON	Shutdown	Not run status
3401 Wire break 102	Wire break supervision			ON	Warning	
3410 Dig. input 105	Coolant temp. high switch		1.0 s	ON	Shutdown	Inhibit 2
3411 Wire break 105	Wire break supervision			ON	Warning	
4000 4-20 mA 91.1	Lube oil pressure low	Engine specific	10.0 s	ON	Warning	Not run status
4010 4-20 mA 91.2	Lube oil pressure low		1.0 s	ON	Shutdown	Not run status + Inhibit 2
4020 W. fail ana 91	Wire break supervision			ON	Warning	
4030 4-20 mA 93.1	Coolant temp. high	Engine specific	10.0 s	ON	Warning	
4040 4-20 mA 93.2	Coolant temp. high		1.0 s	ON	Shutdown	Inhibit 2
4050 W. fail ana 93	Wire break supervision			ON	Warning	
4060 4-20 mA 95.1	Lube oil temp. high	Engine specific	10.0 s	ON	Warning	
4080 W. fail ana 95	Wire break supervision			ON	Warning	
4090 4-20 mA 97.1	Coolant pressure low	Engine specific	10.0 s	ON	Warning	
4110 W. fail ana 97	Wire break supervision			ON	Warning	
4520 Overspeed 2	Overspeed protection	115%	1.0 s	ON	Shutdown	
4540 Run feedb. fail	Supervision of MPU signal during running		1.0 s	ON	Warning	
4550 MPU wire break	Wire break supervision			ON	Warning	

Parameter no.	Function	Recommended settings				
		Setpoint	Delay	Enable	Fail class	Inhibits
4960 U< aux. term. 1	Supervision of power supply (main processor)	18.0 V	1.0 s	ON	Warning	
4980 U< aux. term. 98	Supervision of power supply (M4 board)	18.0 V	1.0 s	ON	Warning	
6000 Nom. settings 1	Nominal generator settings					
6040 G transformer	Generator CT and VT ratios					
6050 BB settings	Nominal busbar settings					
6171 Number of teeth	Set number of teeth on the flywheel	Engine specific				
6172 Run detect. type	Select primary running feedback	MPU				
6173 Running detect.	RPM setting for detection of running	Engine specific				
6174 Remove starter	RPM setting for dis-connection of starter motor	Engine specific				
6181 Start prepare	Start prepare time before cranking	Engine specific				
6183 Start ON time	Crank relay ON time	Engine specific				
6184 Start OFF time	Stop coil ON time before next start attempt	Engine specific				
6201 Shutdown overr.	No. of start attempts in shutdown override mode	Appl. specific				
6202 Shutdown overr.	Cooling down time in shutdown override mode	Engine specific				
6211 Cool. down time	Engine cooling down time before stopping	Engine specific				
6212 Ext. stop time	Time between end of stop sequence and a new start attempt	5.0s				
6270 Stop coil w. break	Wire break supervision			ON	Warning	
6350 Diode comp.	Compensation for voltage drop over the diode in the cranking drop-out circuit	Diode specific				

(i) **Overspeed, low lube oil pressure and high coolant temperature must be set up with wire break supervision and shutdown fail class. This is a classification demand.**

(i) **Please refer to the document 'Parameter list' for a complete list of settings.**

Digital input alarm configuration

To see the parameters for the digital inputs, select the Dig tab:
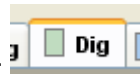
Analogue input configuration

To see the parameters for the digital inputs, select the Ain tab:
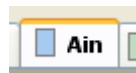

Setpoint: Alarm setpoint and scaling of the analogue signal, e.g. 4-20 mA -> 0-150°C
Timer: Alarm delay
Fail class: The action to be performed in case of an alarm
Output A and B: 'Not used' will activate the horn output only

Input/output configuration

To dedicate specific functions to a digital input, the input/output configuration is used. For this application it is required to dedicate digital inputs to the functions Shutdown override, Remote start and Remote stop.

1. To open the configuration of input functions, use this icon:

2. Dedicate digital inputs to the three functions as shown below.
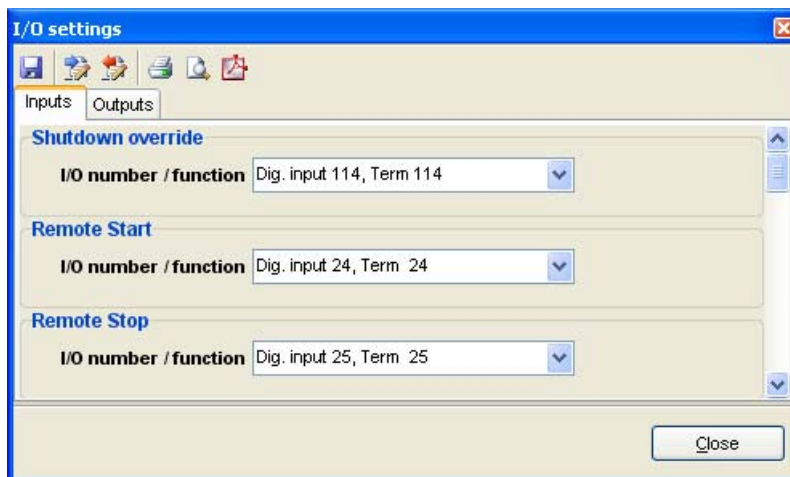
3. Write the configuration to the device:

Display views

This section describes how to configure the views in the display to show the measured engine data required.

1. Click the icon for Views setup:

2. Select View 15.
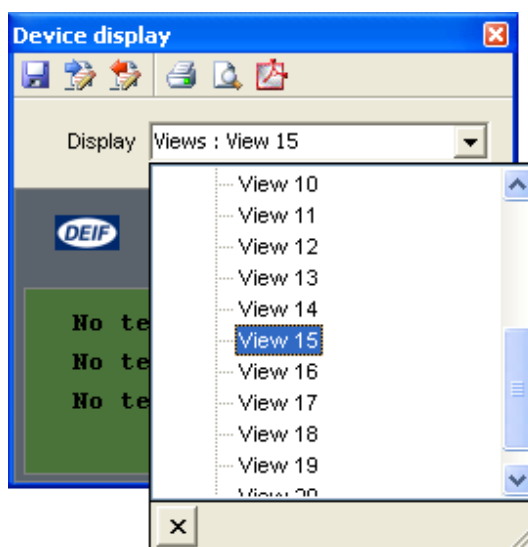
3. Click the first line from the top displaying "No text".
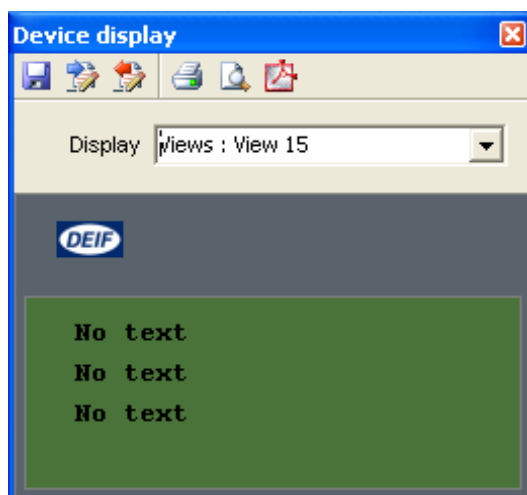
4. Select Tacho from the list and click OK.
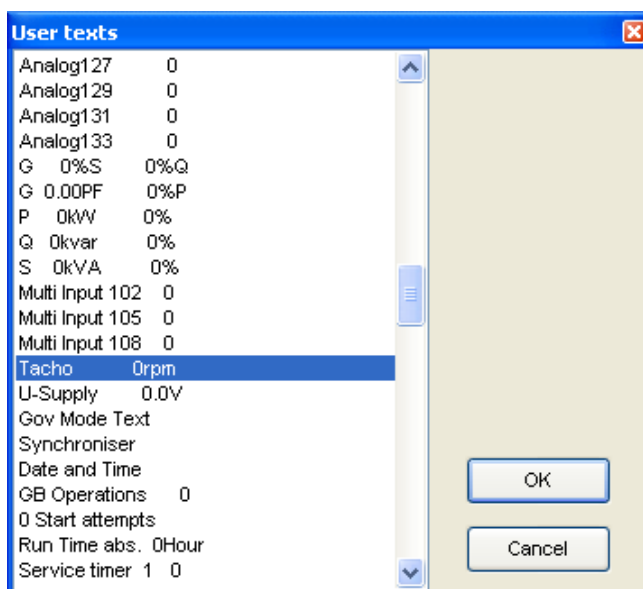
5. Configure View 15 and 16 as shown below.
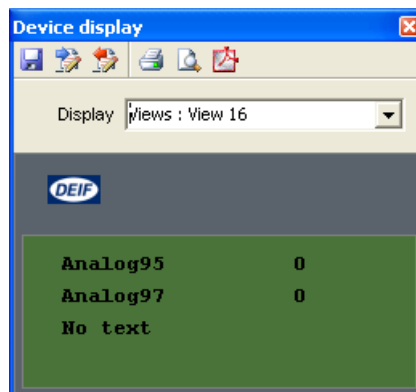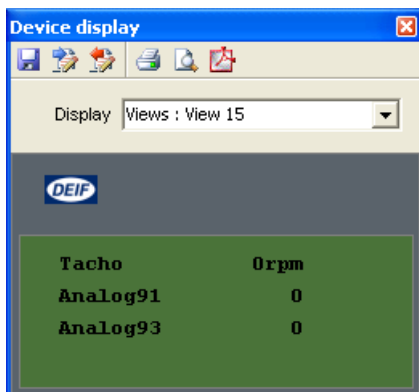
M-Logic

The shutdown override function for the safety system has to be set up in M-Logic to activate Inhibit 2.
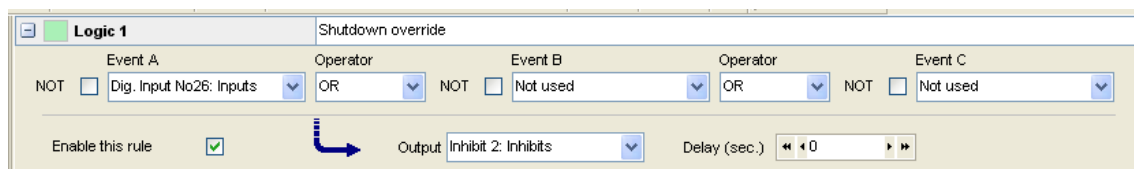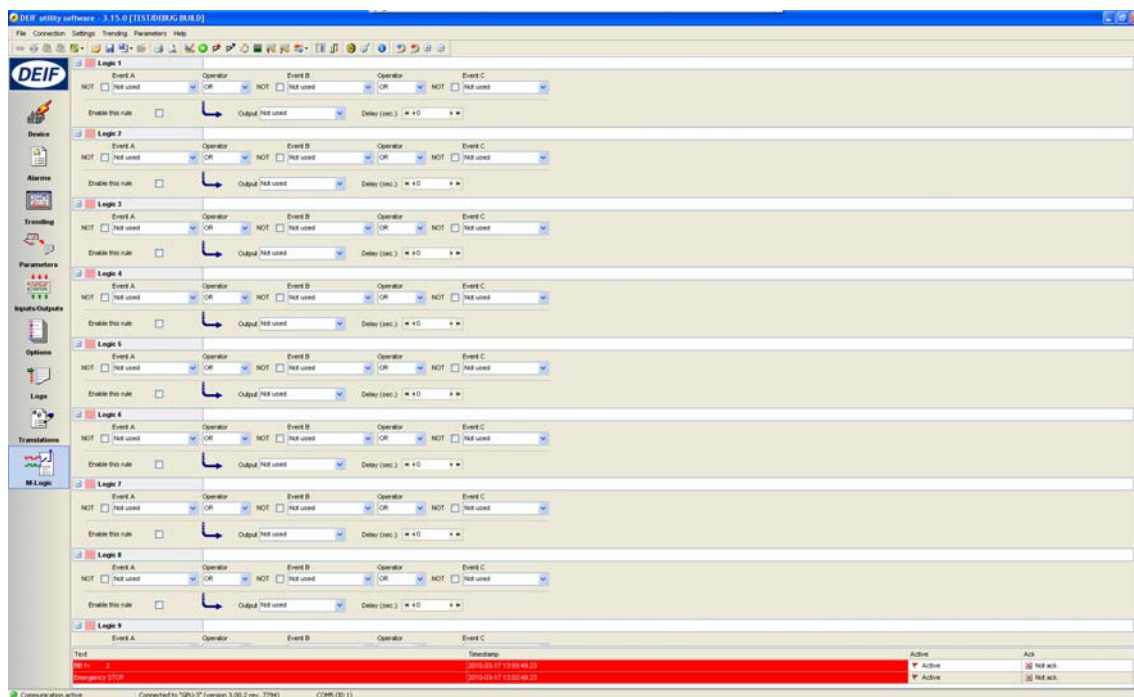
Display and alarm texts

To change the texts of the digital and analogue alarm inputs and measurements, it is required to use the translations function.

Overview of texts which have to be changed:

Default display text	Text to be changed	New text
3400 Dig. input 102	#### Dig. input 102	#### Lube oil P
3410 Dig. input 105	#### Dig. input 105	#### Coolant T
4000 4-20mA 91.1	#### 4-20mA 91.1	#### Lube oil P
4010 4-20mA 91.2	#### 4-20mA 91.2	
Analog 91	Analog 91 ####mA	Lube oil P #####mbar
4030 4-20mA 93.1	#### 4-20mA 93.1	#### Coolant T
4040 4-20mA 93.2	#### 4-20mA 93.2	
Analog 93	Analog 93 ####mA	Coolant T #####°C
4060 4-20mA 95.1	#### 4-20mA 95.1	#### Lube oil T
Analog 95	Analog 95 ####mA	Lube oil T #####°C
4090 4-20mA 97.1	#### 4-20mA 97.1	#### Coolant P
Analog 97	Analog 97 ####mA	Coolant P ####mbar

Please notice that the number signs (#) indicate a parameter number or measurement which cannot be changed.
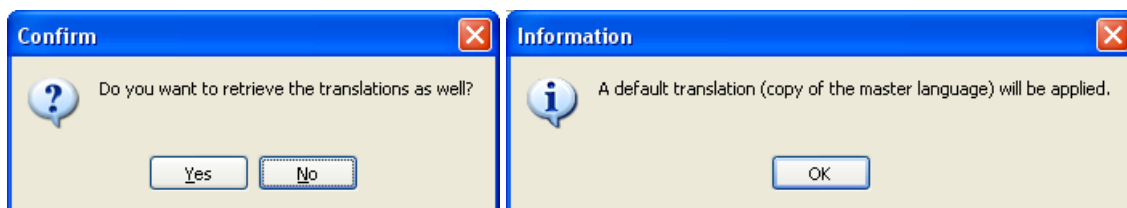
Changing a text

1. Click the icon for translations:
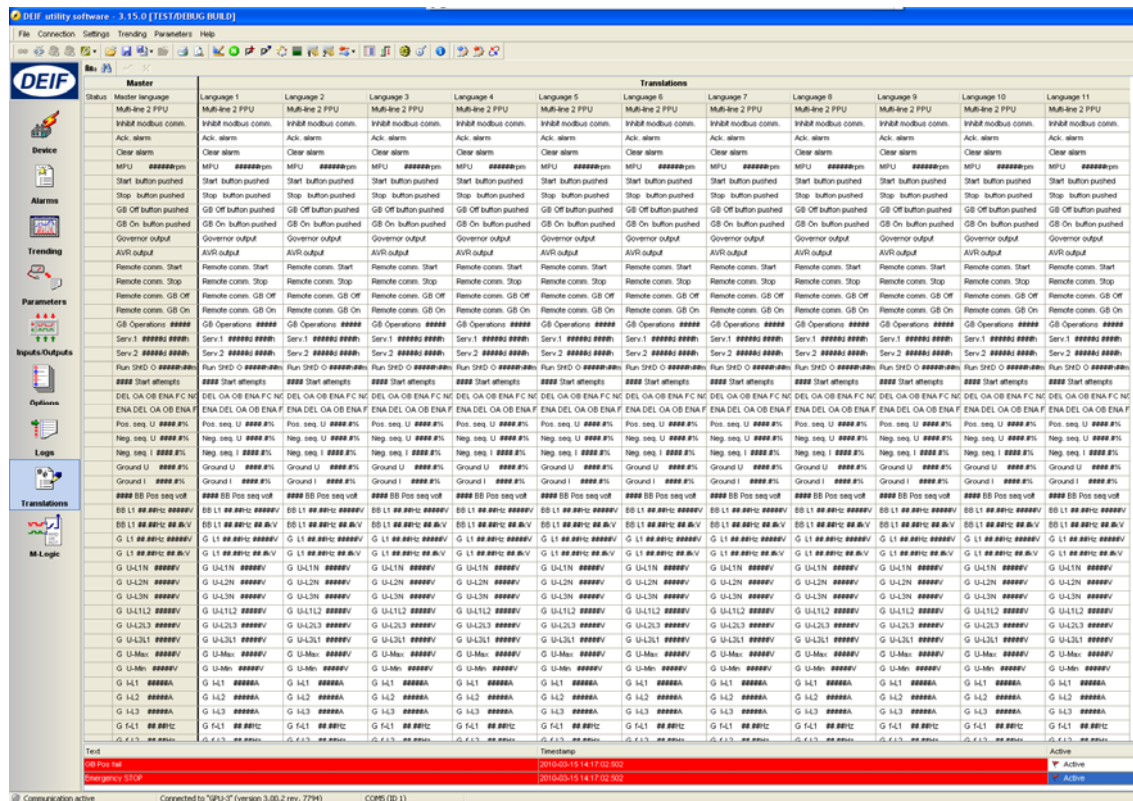
2. Retrieve languages from device.
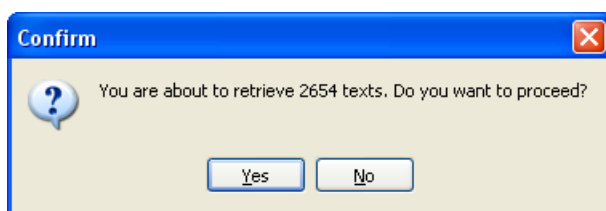
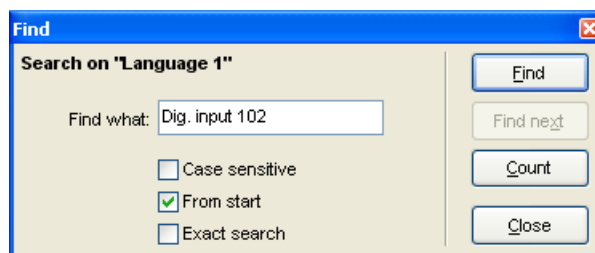Click Yes to start the text transfer.

Click No and then OK.

This will cause the master language to be copied to all columns, and the screen will then look like this:

3. Find and replace text.

Place the cursor in a row of the Language 1 column and click the search icon:

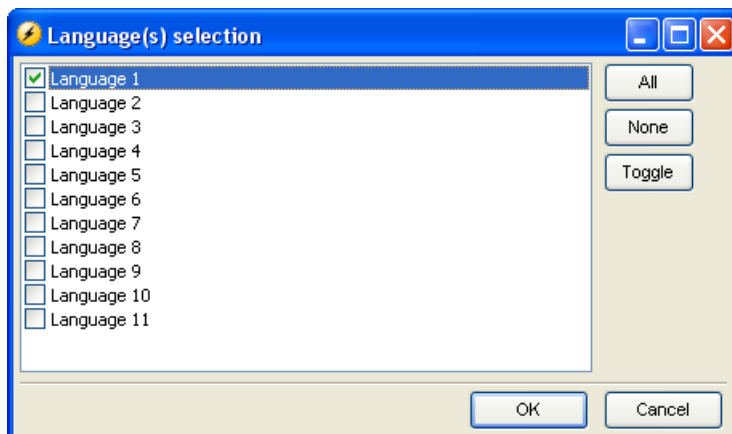To find digital input 102, enter 102 in the search field and click Find.

Close the search window and change the text '#### Dig. input 102' to '#### Lube oil P' and press Enter.
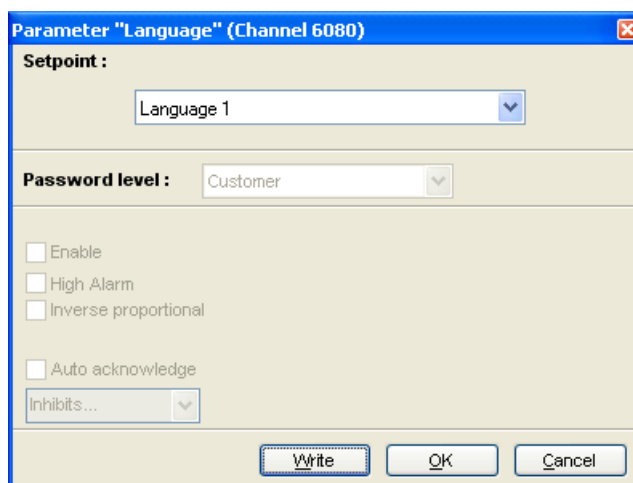
4. Write texts to device.

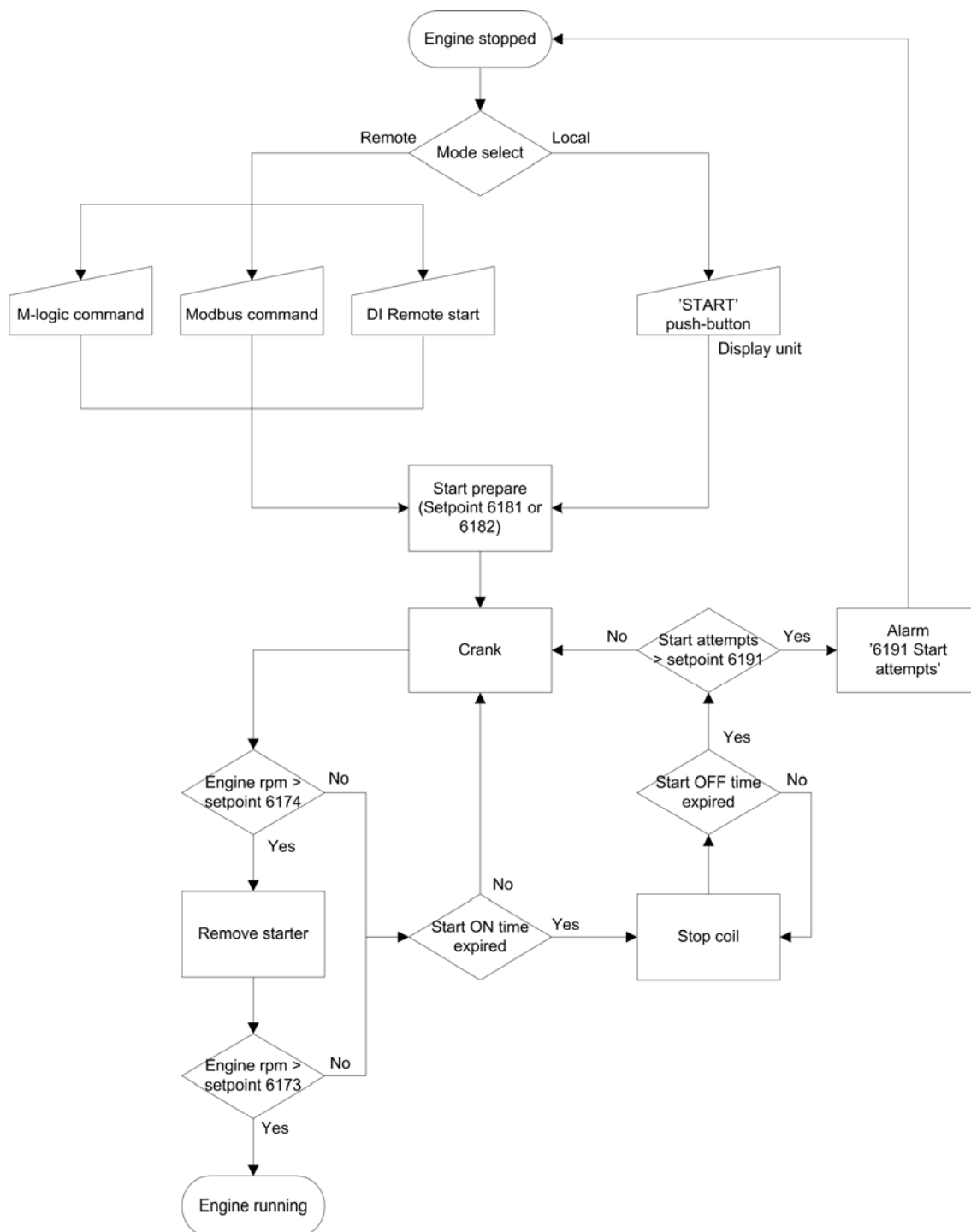Click the icon for writing languages to the device:

Select Language 1 and click OK to start the text transfer.

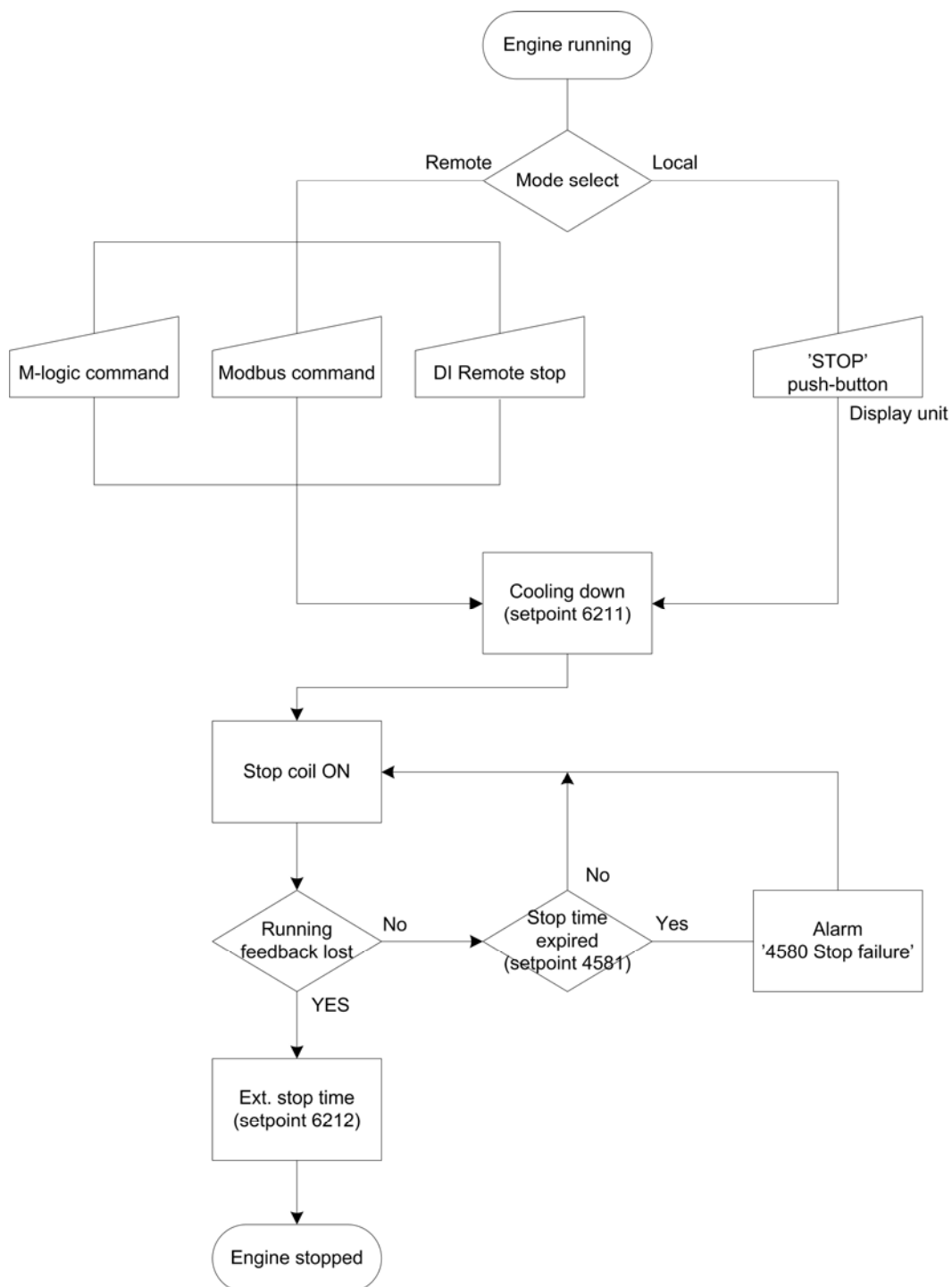5. To activate the new texts, select Language 1 in menu 6080.

9. Flowcharts

Start sequence

Stop sequence