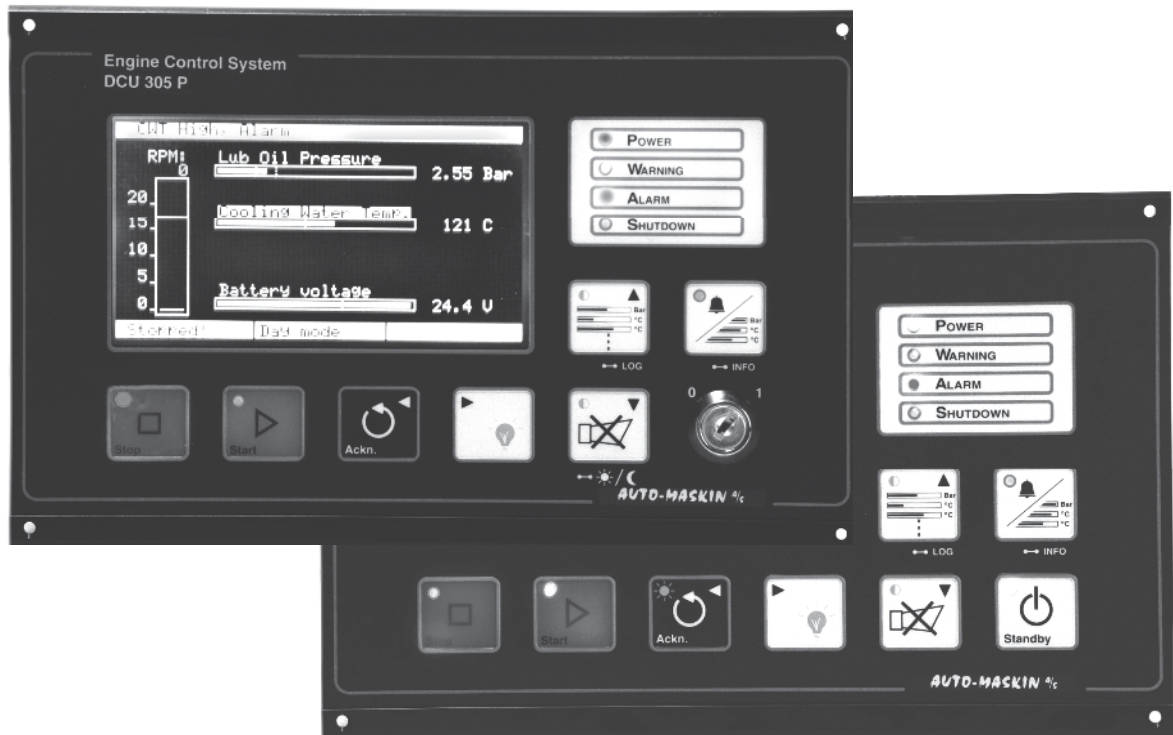


# Installation Manual



## Diesel Engine Control Unit





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# Document information

## **Document revisions**

<b>Date</b>	<b>Revision</b>
October 2002	Created
April 2004	Describes the new layout of the RK-66 R2 module

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## **Related articles**

- DCU 305 R2 User's Manual                      Article 06322
- DCU 305 R2 Communication Manual.        Article 06324
- DCU 305 R2 Slave Panel.                      Article 75290
- Rudolf R2 User's Manual, English.            Article 09326
- Rudolf R2 Configuration Software.         Article 75270

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# Introduction

---

## About this manual

This manual has been published primarily for professionals and qualified personnel. A person using this material is assumed to have basic knowledge in marine systems, and be able to carry out related electrical work.

Work on the boats low-tension circuit should only be carried out by qualified and experienced persons. Installation or work on the shore power equipment *must only* be carried out by electricians authorised to work with such installations.

It is the sole responsibility of the installer to ensure that the installation work is carried out in a satisfactory manner, that it is operationally in good order, that the approved material and accessories are used and that the installation meet all applicable rules and regulations.

---

**Note:** Auto-Maskin continuously upgrades its products and reserves the right to make changes and improvements without prior notice.

All information in this manual is based upon information at the time of printing.

For updated information, please contact your dealer.

---

## Assumptions

### Control units

This document describes the DCU 305 R2 A and the DCU 305 R2 P control units. The DCU 305 R2 A is for auxiliary and emergency projects, whereas the DCU 305 R2 P is for propulsion engine projects.

Installation and operation of the two is similar, and this manual will point out the areas where they differ.

The two units will commonly be referred to as the *Control Unit*.

### Voltages

When referring to voltages, we always assume DC-voltages. When referring to AC-voltages it will be mentioned explicitly.

## About the DCU 305 R2

The DCU 305 R2™ is an electronic control unit for control and monitoring of diesel engines used as propulsion engines or gensets.

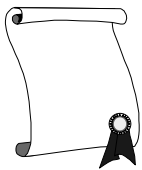
Switches and senders from the engines are connected to the control unit on the wire terminal card RK-66 R2.

The DCU 305 R2 can be connected directly to a printer for output of all alarms and events, or it can be connected to a slave panel in a network of control units.

Each project is unique, which is why the DCU 305 R2 is customised using a configuration tool for Windows®, the Rudolf R2™ software.

## Classified system

The DCU 305 R2 is classified by the following classification societies with their respective certificate number as follows:



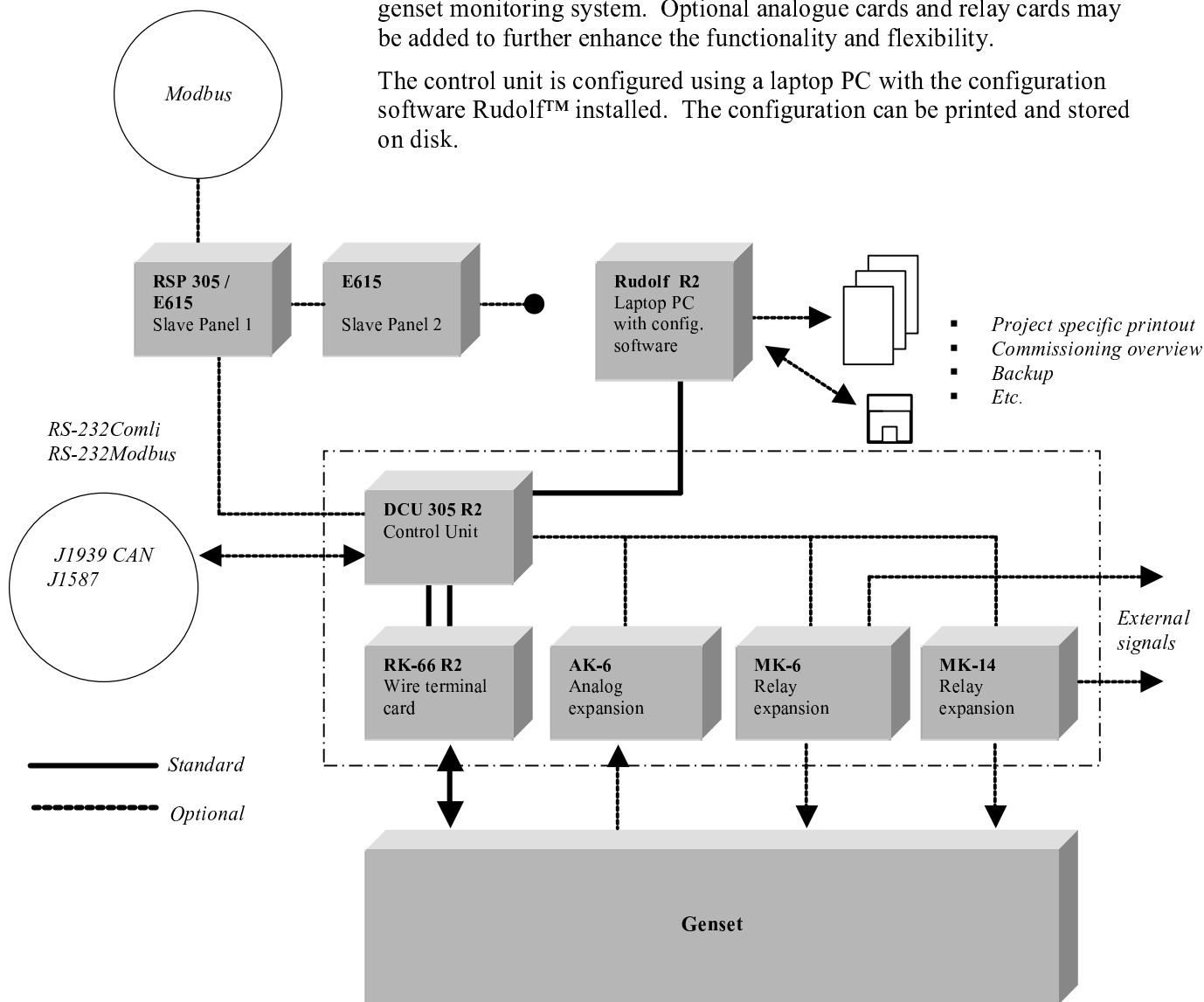
<b>Classification Society</b>	<b>Certificate Number</b>
Det norske Veritas, DnV	A-7403, A-7404, A-7998
Lloyd's Register of Shipping, LR	01/00050, SWC 0100001
Germanischer Lloyds, GL	42 526 – 02 HH
Bureau Veritas, BV	10747/A0 BV
Russian Maritime Register of Shipping, RS	01.013.262
Registro Italiano Navale, RINA	MAC/38901CS1
American Bureau of Shipping, ABS	02-OS-8785-PTA

Other certificates and approvals may exist.  
Please see [www.auto-maskin.no](http://www.auto-maskin.no) for latest update.

# System Overview

The control unit and the wire terminal card with cables make a complete genset monitoring system. Optional analogue cards and relay cards may be added to further enhance the functionality and flexibility.

The control unit is configured using a laptop PC with the configuration software Rudolf™ installed. The configuration can be printed and stored on disk.



## Basic delivery

The *DCU 305 R2* and the *RK-66 R2* is part of the standard delivery that makes a complete system. The other items are optional.

## Slave panels

The optional Slave Panels can be added any time, as it communicates directly towards the *DCU 305 R2*.

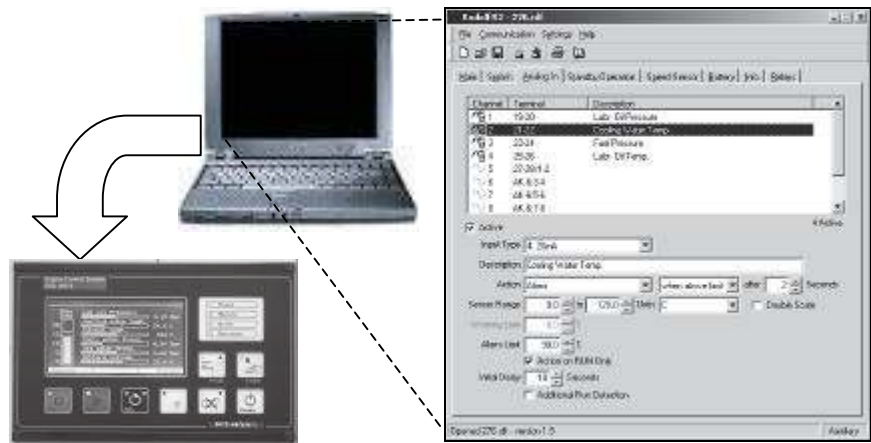
Several Slave panels can be used towards the same *DCU 305 R2*, or one Slave Panel can be used towards several *DCU 305 R2* panels.



## Configuration overview

The control unit is fully customised using the Rudolf™ configuration program. For safety reasons, *no* parameters are adjustable without using the configuration tool Rudolf.

No settings are necessary in the DCU 305 R2, nor in Rudolf, to connect and use the Rudolf program. Just connect the cable between your laptop PC and port P3 on the control unit.



*A PC with the Rudolf™ parameter program is used to customize the DCU 305 R2.*

Discussion of the Rudolf configuration software is beyond the scope of this manual. For more information, please see the *Rudolf R2 User's Manual*.

## Technical Specifications

Part	Value
Overall dimensions (1)	160 x 250 x 35mm (H x W x D)
Cut-out dimensions	146 x 230mm (H x W)
Overall depth inc. cables	105mm
Supply voltage (2)	24V smoothed, (18– 32VDC)
Power consumption (3)	Typical: 500mA @ 24V DC Maximum: 700mA @ 24VDC
Weight	Control unit: 1250g
Protection level	Front panel: IP54 Back panel: IP30

Part	Value	
Ambient temperature	Operation:	0-70°C
	Storage:	-20-70°C
Air humidity	Operation:	<90%
	Storage:	Dry
Analogue alarm latency	Built-in channels:	~1 sec
	Expansion card AK-6:	~5 sec
RK-66 R2 relays	120VAC	1A
	24VDC	1A

## Notes

- (1) *The cables on the backpanel add to the overall depth.*
- (2) *LCD backlight disappears if primary supply is below 18 volts, and reappears when primary supply is above 20 volts.*
- (3) *Display brightness full, 5 x 50% (12mA) analogue inputs.*

# Cable connection

---

## General

To protect against EMC noise, we recommend that all cables be screened.

The screen of all cables shall be connected to ground, not to 0V! Some cables are to be grounded in one end only, others in both ends.

Some cables shall be separate – for instance pickup signal. Others can be in a multicable with screen.

See the example schematics and cable specification for details.

---

## Grounding

*Please observe the difference between Ground and 0 volt!*

Please keep ground and 0V separated!

In marine installations, ground and 0 volt should *not* be connected together. In a ship installation, the hull is the “ground” whilst the battery minus is the 0V.

In the DCU 305 R2 system, +24V and 0V are filtered to ground using special filter components. This is done to avoid noise in the system. If ground and 0V is connected together, these filters do not work properly.

In general, all switches should be referenced to 0V.

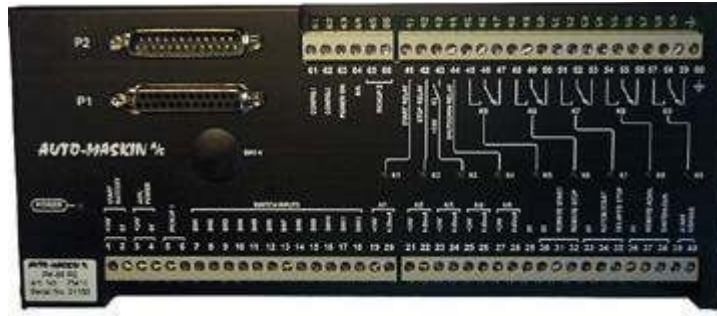
---

## Connection order

All connections are made on the RK-66 terminal card. The only exception is communication cables, and analogue/relay expansion cables, which are connected directly on the backpanel.

Start by connecting the ground cable to terminal 60 on the RK-66 R2 terminal board. Terminal 60 is connected to the *groundplane* (not to 0V) on the RK-66 R2 card.

Connect the two cables between the RK-66 R2 and the control unit.



The RK-66 R2 wire terminal card

Now, connect the rest of the wires and complete the installation by connecting power to the supply inputs.

Terminals 1 and 2 are for the start battery supply, and terminals 3 and 4 are from the auxiliary supply.

## Switch setting

By removing the rubber lid on the front of the RK-66, four dip-switches numbered 1-4 will appear.

Switch	Purpose	Factory Setting
1	When ON, start is enabled. This is the same as connecting a jumper over terminals 39 and 40. When OFF, <u>no starts are possible!</u> Now, a jumper between terminals 39 and 40 will enable start.	ON
2	When ON, bypasses the return path diode to start-battery negative (terminal 2), which in some installations may reduce noise interference. Increases the measured battery voltage by 0.3V.	OFF
3	Noise filter between terminal 1 and 3 to ground. Set the switch to ON to enable the filter.	OFF
4	Noise filter between terminal 2 and 4 to ground. Set the switch to ON to enable the filter.	OFF

## Power supply

### 24V supply

Use a twisted pair wire to minimize the effect of noise on the cable.

The start battery power must be connected to terminal 1 and 2. This is the *primary* supply. The *secondary* (or auxiliary) supply is connected to terminal 3 and 4.

---

**Note:** In a classified system, a redundant supply *must* be connected to terminals 3 and 4.

---

The control unit uses the highest voltage available. The *primary* voltage is constantly monitored and displayed on the LCD.

The control unit alarms if the *primary* supply is below the configured value, or when the *secondary* supply is below 12V (fixed setpoint).

The LCD light disappears when the *primary* voltage drops below 18V, and reappear when the *primary* voltage rises above 20V.

## 12V supply

The DCU 305 R2 is a 24V system, but can be used in 12V systems using an external DC/DC converter. The configuration in Rudolf must be switched to a 12V system.

Connect the start battery to the *primary* input at terminal 1 and 2 as above. This voltage is not high enough to make the control panel work, but it measures the battery voltage.

Connect a 12/24V DC/DC converter to the 12V start battery, and connect the 24V output to the *secondary* input, terminal 3 and 4.

---

## Start- and Stop Relay Outputs

Connect auxiliary relays for Start (cranking), Stop, Run solenoid and Shutdown solenoid.

Observe polarity if the relay coils are fitted with voltage suppressor diodes.

Coil resistance on auxiliary relays must be in the range 250ohm-2kohm.

---

## Pickup sensors

Connect the pickup 1 between terminal 5 and 6. Please verify that the signal strength is between 2.5-30Vpp.

---

**Note:** The pickup cable must be shielded to ground, NOT to 0V.

---

### Two pickups

If two pickups are being used, connect the second pickup to terminal 65 and 66. If the rpm differs >100rpm for 20 seconds, there will be an alarm on the pickup with the *lowest* rpm.

The signal from pickup 1 has precedence, unless the frequency from pickup 2 is >100rpm higher than pickup 1, where pickup 2 will be used.

---

**Note:** Two Pickups must be *enabled* in Rudolf before it can be used.

---

## Switch Input Channels

The control unit has 12 on/off inputs. All 12 inputs can be fully customised with text, delays and instructions to give a Warning, Alarm or Shutdown.

Channel	1	2	3	4	5	6	7	8	9	10	11	12
Terminal #	7	8	9	10	11	12	13	14	15	16	17	18

*Switch Input Channels and their corresponding wire terminal number on the RK-66 R2 wire terminal card.*

Inputs are connected to the Wire Terminal Card RK-66 as in the above table.

The six first switch input channels can detect a broken wire situation, and utilizes a backup system for shutdown purposes. See page 17 for more information on the backup system.

---

**Note:** In a classified system, all *shutdown* switches must be connected to switch inputs 1-6.

---

The following table illustrates the capabilities of the switch input channels.

Channel	Broken Wire Detection possibility	Backup on Shutdown channels	Warning, Alarm and Shutdown possibility
1-6	Yes	Yes	Yes
7-12	No	No	Yes

---

**Note:** Do *not* connect +24V to the switch inputs! All input switches must be connected via its corresponding wire terminal to 0V, *not* to ground. Please see the schematic drawing page 31.

---

### Connecting the Switches

Connect the warning, alarm and/or shutdown switches according to the project documentation and drawings. All switches must be connected between a wire terminal (7-18) and 0V.

An open (not connected) input is pulled 'high' internally. The external switch must pull the input 'low' (0V).

---

**Example:** Switch channel 1 might be the Oil Pressure Low Shutdown. The switch is then connected between Terminal 7 and 0V.

---

## Wire break detection

Channel 1-6 has the ability to detect wire break. This is useful in conjunction with the channel being used as a shutdown channel.

A **10k** resistor (10 000 ohm) must be connected in parallel with the switch. The resistor must withstand 1/8W (0.125W) or more.

---

**Note:** The Wire Break Detection feature must be enabled in Rudolf for each of the channels 1-6 that are being used. Otherwise, there will not be a Broken Wire alarm.

---

The control panel will now issue a “Broken Wire” alarm if the wire into the control panel is broken. The alarm is delayed 5 seconds (fixed time).

An alarm is displayed as:

\* Broken Wire [T9]

Here, there is a broken wire on T9, terminal 9. Terminal 9 is switch channel 3.

### **Considerations when using wire break detection**

Make sure the return-path from the external switch is connected to 0V (terminal 29) close to the connection card RK-66 R2, not at the engine.

The reason being that the control unit measures voltage differences, and there could be a substantial voltage difference between 0V at the RK-66 R2 card, and 0V at the engine.

Too great voltage difference may trigger the “Broken Wire” alarm erroneously.

---

## Analogue Input Channels

The control unit has five industrial-standard 4-20mA inputs. These may or may not be used, and – if used – are displayed on the LCD as horizontal bars.

**Note:** An optional expansion card, the AK-6, is available to expand the number of analogue inputs from 5 to 11. Please see page 23 for details.

Using Rudolf, *all* 11 analogue channels can be configured as a 0-20mA or 4-20mA type. Channel 1 only can in addition be configured as 0-10V.

---

**Note:** If channel 1 is used as 0-10V, use a separate shielded cable for this signal as the 0-10V signal is highly susceptible to noise.

---

All analogue channels can be customised with text and delays and whether to issue a Warning, Alarm or Shutdown.

---

**Note:** Analogue channel one only, can be configured as a 0-10V channel. The dipswitch **J12** inside the unit must be set as follows:

---

0-20mA / 4-20mA   
 0-10V 

Please note that this is applicable for analogue channel one only! Default setting is 0-20mA / 4-20mA.


### Analogue channel setpoints

In the display, the following markers are used to distinguish between different types of setpoints:

None		No setpoint
Warning		Dashed line
Alarm		Single line
Shutdown		Double line

The alarm *Analogue Sensor Failure* appears if an enabled analogue input is not connected, or if the signal strength is too low (<2mA).

Instead of a value to the right of the bargraph, the sign “----“ will be displayed, for instance like this:

Oil Pressure OP1  
 ---- Bar

If 0-10V or 0-20mA is selected, the *Analogue Sensor Failure* alarm will not appear.

### Connecting the Analogue Sensors

Connect the sensors according to the project documentation and drawings. All five analogue input channels are 0/4-20mA or 0-10V (channel 1 only).

For PT100 and PT1000 sensors, an appropriate signal converter must be used.

Analogue Channel	RK-66 R2 terminal number	
	+24V supply to sensor	Analogue input
1	19	20
2	21	22
3	23	24
4	25	26
5	27	28

*Analogue Input Channels and the corresponding wire terminal number on RK-66 R2*



Terminal 19, 21, 23, 25 and 27 are all +24V supply *outputs*. These outputs are fused with a common, internal, automatic fuse (F3). The fuse is located on the RK-66 R2 card.

The fuse will automatically reset when the overload or short circuit is removed. An alarm is given if the fuse blows and the alarm stays activated as long as the short circuit is present.

For fuse sizes and characteristics, please see page 17.

---

**Example:** Analogue channel 1 might be the Oil Pressure sensor. The sensor is then connected between terminal 19 (+24V supply) and terminal 20 (4-20mA input).

---



---

## Miscellaneous connection

Please also refer to the schematics, page 31, for the following connections.

### Remote Start

Remote Start works as the local Start Button.

Connect terminal 31 to terminal 30 to engage.

### Remote Stop

Remote Stop works as the local Stop Button, except it is immediate

Connect terminal 32 to terminal 30 to engage.

---

**Note:** For safety reasons, local and remote Start and Stop works regardless of the Manual and Standby setting.

---

### Remote Reset (Acknowledge)

Connect terminal 37 to terminal 36 to activate Remote Reset.

This works as the local reset button on the frontpanel, and reset all the current alarms.

### Blackout Start

When the control unit is set to Standby and receives this signal, it will initiate the Automatic Start procedure. The number of start attempts is configured in Rudolf.

Connect terminal 34 to terminal 33 to activate. See the schematics on page 31.

When the engine has started, the signal can be removed. The engine will not stop if the signal is removed.

---

**Note:** If Blackout Start and Delayed Stop are connected simultaneously, Blackout Start is given priority.

The Delayed Stop signal has no effect if the Blackout Start signal is present.

---

## Delayed Stop

When the control unit receives the Delayed Stop signal, it will disconnect the gen. breaker and run the genset for the predefined cooling time before stopping.

Connect terminal 35 to terminal 33 to engage. Also, see schematic page 31.

## Power-On

Terminal 63 can be used as an external power-on. Connect terminal 63 to +24V to activate.

- In the propulsion unit *DCU 305 R2 P*, the terminal 63 works in *parallel* with the key-switch on the frontpanel. This means that the key switch in the front panel and terminal 63 may power the control unit separately.
- In the auxiliary unit *DCU 305 R2 A*, the jumper J1 inside the main unit must be removed for this feature to work. With the jumper on, the control unit is always powered.

### How to remove the jumper J1

Remove the back lid. The jumper J1 is located in the bottom left corner.

## Shutdown override

On auxiliary gensets, shutdown may be overridden by connecting terminal 38 to terminal 36.

All shutdowns are now *disabled*, except for overspeed. The shutdown channels will trigger an alarm instead.

**Note:** If *in* shutdown, applying Shutdown Override will *abandon* the current shutdown.

## Configurable inputs

Terminal 61 and 62 are user defined. They are activated by connecting the terminal to 0V.

For available functions, see the *Rudolf R2 User's Manual*.

---

## The automatic fuses on the RK-66 R2 module

The RK-66 R2 wire terminal card has six automatic fuses.

- Fuses F1, F2 and F5 are used by the DCU 305 R2 to secure internal circuits.

These fuses are of type Raychem Polyswitch™ type RXE090. Maximum load must be less than 1.4A.

- Fuse F6 secures the +24V power for the analogue channels at terminal 19, 21, 23, 25 and 27.  
Fuse F3 secures power for the relays connected to terminal 41-44. See the schematics on page 31.
- Fuse F4 secures the 0V on terminals 29, 30, 33 and 36.

The fuses F3, F4 and F6 are of type Raychem Polyswitch™ type RXE050. Maximum load must be less than 0.8A.

If the values are exceeded, the fuse will eventually blow. When the overload is removed, the fuse repairs itself. Typical recovery time is 15-20sec at 20°C ambient temperature.

---

## Backup system configuration

### Overview

In the unlikely event of failure in the DCU 305 R2 main microcontroller, the built-in backup system will detect this, and set the common alarm output relay.

Likewise, if the backup system fails, the main microcontroller will issue the “Backup System Failure” alarm.

---

**Note:** The backup system setting is calculated automatically by Rudolf R2.

Set the DIP-switches according to the Rudolf R2 recommendation.

---

**Note:** The backup system activates if the main microcontroller fails only. When the control panel is working normally, the backup system is *enabled*, but not *activated*.

The working of the backup system can be observed on the back panel as a slowly flashing (~1Hz) green LED. If the LED is flashing quickly, (~4Hz) the backup system has detected a main microcontroller failure and is activated.

---

The backup system monitors all of the *enabled* switch inputs channels 1-6, and overspeed. These are the only channels on which the backup system can act.

## How it works

If the backup system is activated and a genuine shutdown appears, it activates the Stop and Shutdown outputs on terminal 42 and 44.

These outputs are held active for 2 minutes before being released.

## Configuration of dipswitches

All configurations of the backup system is done using switch S1-S4 on the back-panel. There are three settings to be made:

- Set *pulses/revolution* using hex-switch **S1** and **S2**.
- Set the *overspeed* setpoint using hex-switch **S3**.
- Enable *shutdown switch channels* by setting dipswitch **S4**.

### ***Pulses/Revolution, S1 and S2***

Set the pulses/revolution on pickup #1 (connected to terminals 5 and 6) by switching the two rotary hex-switches S1 and S2 to the correct value.

See the *Appendix* page 41 for details.

MS is the *most significant* value whereas LS is the *least significant* value.

---

**Example:** A pickup issues 165 pulses/revolution. 165 decimal = A5 hex.

A is the MS; 5 is the LS.

Set S1 = A

Set S2 = 5

---

### ***Overspeed, S3***

---

**Note:** The Backup System measures rpm from pickup 1 only.

---

Set correct overspeed setpoint by turning the hex-switch as follows:

Switch S3	Value [rpm]	Switch S3	Value [rpm]
0	<i>Disabled</i>	8	1800
1	480	9	1885
2	670	A	2010
3	1025	B	2030
4	1370	C	2120
5	1670	D	2340
6	1720	E	2430
7	1760	F	2730

Select the next value that is *above* the Rudolf R2 overspeed setting.

**Example:** If the main configuration overspeed is set to 1740, then set the S3 switch to 7, ie. 1760 rpm.

### Shutdown channels, S4

There is a dipswitch in combination with each of the first six switch channels.

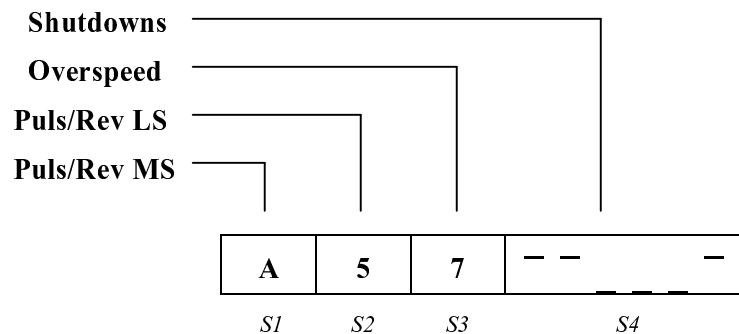
The DIP-settings are for selection of the shutdown channels. All of the channels 1-6 that are configured as shutdown must have its corresponding DIP set to ON.

In the example below, channels 1, 2 and 6 are set as shutdown channels.

**Note:** The backup settings **MUST** correspond with the Rudolf R2 configuration.

When the DIP is set to ON, it means these channels will be monitored by the backup system.

In the backup system, there is a four second delay before pulling the stop-solenoid. Once activated, the stop-solenoid remains activated for 2 minutes to allow the engine to completely stop. The stop-solenoid then deactivates.



*Example of Backup System setting.*

*The above example is a system with shutdowns on channel 1, 2 and 6, overspeed set to 1760 rpm and 165 pulses/revolution (see text above)*

In the above example, channel 1, 2 and 6 are shutdown channels. Here, channels 3, 4 and 5 may be configured as Warning or Alarm channels, or may not be in use.

## Built-in Alarms

The control unit has a number of internal alarms. These are always displayed – in the language selected by Rudolf.

The following is a list of the built-in alarms.

Alarm text	Comment
Low battery voltage	Low voltage at the start battery.  The alarm is interlocked during starting (cranking) and stopping.
Secondary battery low voltage	Low voltage at the secondary battery source.
Overspeed	Engine running faster than the overspeed setpoint.
Engine Stopped	Engine stopped for no known reason.
Engine failed to stop	60 seconds after issuing the stop command, the engine has still not stopped.
Start Failure	Engine failed to start after the last start attempt.
Pickup failure	Unable to read the pickup signal while engine is running.
Output circuit overload	Short circuit in one of the +24V outputs.  The outputs are secured with fuse F3 that makes an automatic reset. Remove the overload to correct the problem.  For details, see page 17.
Analogue sensor failure [A7]	Detailed information on which analogue channel that is below 2mA. Here channel 7.
Broken wire [T7 T9 T44]	Information on which terminal has a broken wire. Here on terminal 7, 9 and 44.

## Adjusting the LCD screen

The control unit uses a graphical Liquid Crystal Display.

The optical performance of the display changes with temperature, light conditions and age.

There is a built-in automatic compensation for temperature changes. Still, from time to time, it may be necessary to adjust the display.

### Automatic Backlight Shutoff

To preserve LCD lifetime, the display automatically shuts off after the predefined amount of time, if no action has been observed in that period.

The display turns on again at any key press, or if an event occurs in the system.

---

**Note:** The terminals 61 and 62 can be configured as LCD Backlight On. 0V on the terminal will trigger the LCD Backlight On.

---

## Contrast

Contrast is automatically compensated for with temperature.

If however the display seems dim or unclear, it may be necessary to adjust it. This is done by pressing and holding the Lamptest button, and then pressing the Up- or Down arrows, ▲/▼.

The Up arrow gives a lighter display (less contrast); the Down arrow gives a darker display (more contrast).

The new setting is automatically stored in internal memory, and stays resident regardless of future power loss.

## Brightness

It is possible to change between half and full light intensity.

This is done by pressing and holding the Lamptest button, and then pressing the Ackn. button. Each press of the Ackn. button now toggles between half and full display intensity.

This setting is NOT stored. After a power loss, the control unit starts over with full light intensity again.

## Day / Night mode

In the DCU 305 R2 P propulsion unit only, *day* or *night* light conditions can be selected.

Pressing the Buzzer Off button for ~1 second toggles the selection. The middle status field will indicate the selection with the text “Day” or “Night”.

### ***Day mode***

This is the standard operation mode. LCD backlight is on and LEDs are on. The timeout for the LCD backlight is as configured in Rudolf.

### ***Night mode***

In normal situations, LCD backlight is off and LEDs are off.

If a Warning condition occurs, only the Warning LED will flash. The LCD will remain dark.

In an Alarm or Shutdown situation, the LCD backlight is set to half bright and LEDs are powered.

The LCD and LEDs turns off 5 seconds after acknowledge.

---

## Overspeed test

This section describes how to enter the RPM-test mode. In test mode, the Overspeed Setpoint (typically 1725 rpm) is reduced to Nominal Setpoint (typically 1500 rpm).

---

**Note:** The actual setpoints may vary from the above example. Consult the Rudolf configuration.

---

### How to enter the RPM test mode

Follow these steps to enter the RPM-test mode:

- Enter the Information view by pressing Info (top right button) for 2 seconds.
- In the Information view, press and hold Lamptest (bottom right button) for 20 seconds – until a beep is heard.

The Overspeed Setpoint is now reduced to the Nominal Setpoint. The bottom left status field displays “RPM TEST ” to indicate and remind of this.

---

**Note:** The test automatically times out after 4 minutes. To leave the test earlier, press Lamptest once in the Info view.

It is not possible to enter the RPM TEST mode unless the control unit is in the Ready state.

---



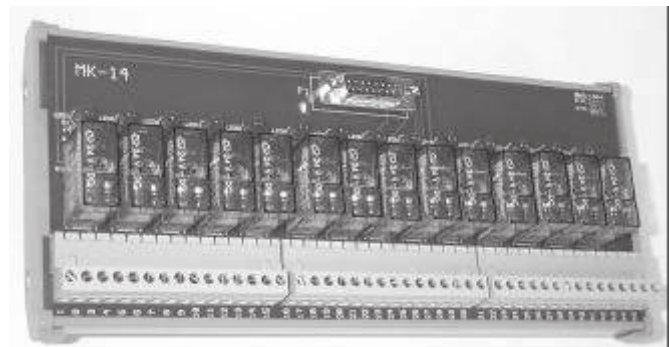
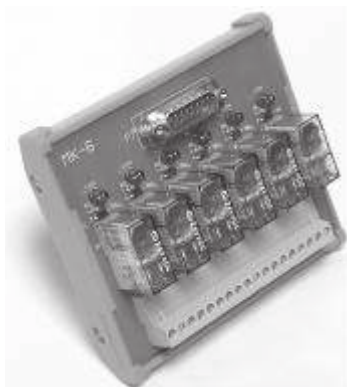
# Optional expansion modules

---

## Relay cards MK-6 and MK-14

In addition to the nine relays found on the RK-66 terminal board, an optional relay card may be connected.

The relay cards are available in two sizes – 6 and 14 relays – named MK-6 and MK-14 respectively. Only one relay card may be connected.



*The optional MK-6 and MK-14 relay cards, that add six or 14 relay channels to the DCU 305 R2. The function on each relay is configured using the configuration tool Rudolf.*

All relays can be given *any* function from an extensive signal pool.

The relay card is connected to the control unit with a shielded 15-pin D-SUB connector cable, and is then ready for use.

The relays are rated 220V/5A.

For connections, please see page 38.

## Available signals to the relay cards

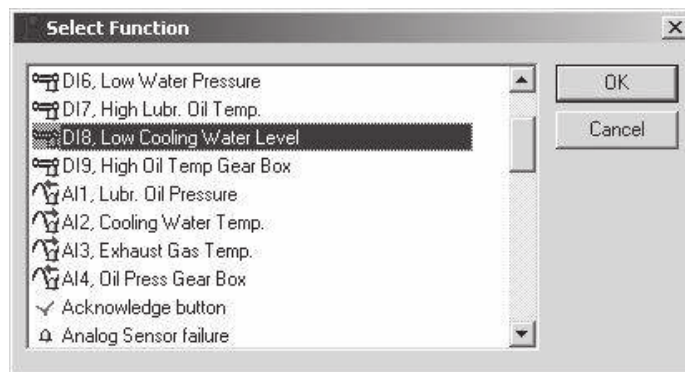
These are all the available signals in the DCU 305 R2 that can be routed to any of the relays on the relay cards.

Relay K7 and K9 on the terminal card RK-66 R2 are configurable in the same manner.

Signal	Comment
Acknowledge button	Manual press of the Acknowledge button.
Analogue sensor failure	An analogue input (4-20mA) is defined but the signal is less than 2mA.
Backup system failure	The backup system is not working.
Buzzer active	Buzzer is activated.
Buzzer off button	Manual press of the Buzzer Off button.
Common analogue input current overload	The sensor fuse is blown. The fuse resets itself when the short circuit is removed.
Common shutdown	Sum of all shutdown channels.
Common warning	Sum of all warning channels
Cooling state	The genset is cooling and running at no load.
Cranking state	The Control Unit signals the start motor. The genset is cranking. On between start attempts also.
Delayed stop activated	The Control Unit has received signal saying the genset will eventually stop.
Disconnect gen breaker relay activated	The generator circuit breaker relay is activated.
Downloading parameters	A new configuration is being transmitted to the control unit.
Engine started	The Control Unit detects the engine is running but no start signal has been detected.
Engine stopped for unknown reason	The engine stopped for no known reason.
First start attempt failed	The <i>first</i> of several start attempts failed during automatic start.
Local mode	LOCAL mode is selected, and no remote commands will work.
Lamp test button	Manual press of the Lamp test button.
Manual mode	The Control Unit is set to Manual mode.
Manual stop	Manual Stop button, local or remote.
Overspeed	Engine speed too high. Stays until Acknowledged.
Pickup failure	Unable to detect a valid pickup signal. Dependent upon at least one defined <i>Additional RUN Detection</i> .

Signal	Comment
	Sum of pickup 1 and 2.
Preheat	Preheating before and during start attempts. Stays on until engine has started or failed to start.
Ready to start	The genset is ready to start.
Ready to take load	The engine has reached the in Rudolf predefined rpm-setting.
Running state	The genset is running. On as long as the engine is running. Same as green LED in the Start button.
Secondary battery failure	The secondary battery is not connected or its voltage is below 12V. Terminal 3 and 4.
Shutdown override on	The Control Unit is disabling shutdowns, except overspeed.
Shutdown override off	The Control Unit has all configured shutdowns enabled.
Standby mode	The Control Unit is set to Standby mode. Automatic starts can take place.
Start battery low voltage	The engines start battery has low voltage. Terminal 1 and 2.
Start command externally	Same as the Blackout signal, e.g. from main switchboard. Terminal 34.
Start disabled	The Control Unit is disabling local and remote start attempts, also when set to Standby.
Start failure	The engine did not start after final start attempt.
Stop failure	A stop signal was given but after 40 seconds, the engine is still running.
Stopped state	The engine has stopped. Engine speed is less than 5rpm.
Stopping state	The engine is about to stop.

All channels – analogue or switch – configured as a warning, alarm or shutdown can be routed to any relay.



*A screenshot from the configuration tool Rudolf R2, where signals are selected to the relays.*

## Analogue card AK-6

The analogue card AK-6 connects directly into the DCU 305 R2. Another six analogue channels are then available in the control unit, to make 11 channels.

The card has two 15-pin D-SUB connectors. One connects directly to the control unit. The other connects to the optional relay expansion cards MK-6 or MK-14, if used.

If any of the analogue channels 6-11 are activated in Rudolf, the control unit assumes the AK-6 card is connected.

All input channels on the AK-6 are of type 4-20mA.

---

**Note:** The update time for the six expansion channels is longer than for the five standard channels. The standard channel 5 will also have longer update intervals when AK-6 is used. We recommend connection of “slow” media to the AK-6 card, eg. temp. transmitters.

**Note:** When using the AK-6 card and the MK-14 card together, the last three channels (channel 12, 13 and 14) on the MK-14 are unavailable.

---



*The optional AK-6 analogue card, which adds six 4-20mA channels to the DCU 305 R2.*

## Connections

The fifth analogue input on the RK-66 R2 card (terminal 27 and 28) becomes the first analogue input on the AK-6 card.

If there is a connection at terminal 27 and 28 on the RK-66 card, move these to terminal 1 and 2 on the AK-6 card.

Consider the following table when using the AK-6 analogue expansion card.

Channel	RK-66 terminal #		AK-6 terminal #		Screen
	+24V	4-20mA	+24V	4-20mA	
1	19	20			1
2	21	22			1
3	23	24			1
4	25	26			1
5	<del>27</del>	<del>28</del>	1	2	1
6			3	4	2
7			5	6	2
8			7	8	2
9			9	10	2
10			11	12	2
11			13	14	2

*For further connection information, please see the schematic.*

On the AK-6, connect terminal 27, 28 and 29 directly to terminal 27, 28 and 29 on the RK-66.

Terminal 29 on the AK-6 is a 0V that can be connected to sensors that need a +24V and a 0V connection. Otherwise, disregard it.

Terminals 15 and 16 on the AK-6 are not in use.

## Displaying the analogue values

As illustrated in the table above, channel 1-5 will be displayed in the first analogue screen, along with the battery voltage (standard).

Screen 2 displays channels 6-11. Screen 2 is not available if none of the channels 6-11 are in use.

# Communication

The information from sensors and switches connected to the DCU 305 R2 can be remotely monitored by utilising the built-in communication channel.

Any common supervision system like Factory Link®, InTouch®, etc. that supports the *Comli* or *Modbus<sup>1</sup>RTU* protocols can be used.

When connected, most data available on the DCU 305 R2 display is available in the supervision system. In addition, commands such as Start, Stop and Acknowledge alarms can be done.

---

## Protocol and pin-configuration

The DCU 305 R2 has the Comli and Modbus RTU communication protocols built-in. It communicates at 9600 baud on its RS-232 communication port.

In order to communicate, the control units ID-number must be known. This ID-number may be any number in the range 1-239. The printout documentation from Rudolf includes the ID-number.

Please refer to the *DCU 305 R2 Communication Interface* for a complete reference when communicating to the control panel.

The control panel has a 9-pin D-SUB male connector outlined as follows:

Pin #	Description
2	RxD
3	TxD
4	DTR
5	SG
7	RTS
8	CTS

---

<sup>1</sup> Modbus is available from firmware 4.25.

---

## Multidrop communication

Several DCU 305 R2 units may be connected together in what is known as a *multidrop* network.

For this to work correctly, each of the connected units must have its unique ID-number in the range 1-239. This is done using the parameter program Rudolf R2.

Further, the multidrop net must be an RS-422 net. This means that RS-232/RS-422 converter units, for instance the Phoenix PSM-ME RS-232/RS-422 unit, must be connected close to the communication port of each DCU 305 R2 unit. We recommend using a screened twisted pair cable with two pairs of at least 0.22 mm<sup>2</sup>, and capacity lower than 60pF/m.

Please contact your dealer or Auto-Maskin for correct dip setting and cabling of these units in a network.

---

## Retrieve the log to a PC

The built-in event log in the control unit can be retrieved with simple means. In Rudolf R2, select Communication – Retrieve Log...

If Rudolf R2 is not available, a laptop with a terminal program like *Hyperterm* or similar can be used.

### Connect and set up communication parameters

Start the terminal program and adjust the communication parameters as follows:

- 9600 baud
- 8 databits
- 1 stopbit
- Odd parity

Connect the Rudolf R2 cable, or use a cable with the following outline:

Laptop PC, COM 1	DCU 305 R2, P3
9 pin female D-SUB	9 pin female D-SUB
2	3
3	2
5	5

## Functions

When the cable is connected and the communication parameters of the terminal-program are adjusted, proceed here.

---

**Note:** The syntax is <ESC> + <Character>.

---

The <ESC> key must be followed by an UPPERCASE <character> within 3 seconds.

The following functions are available:

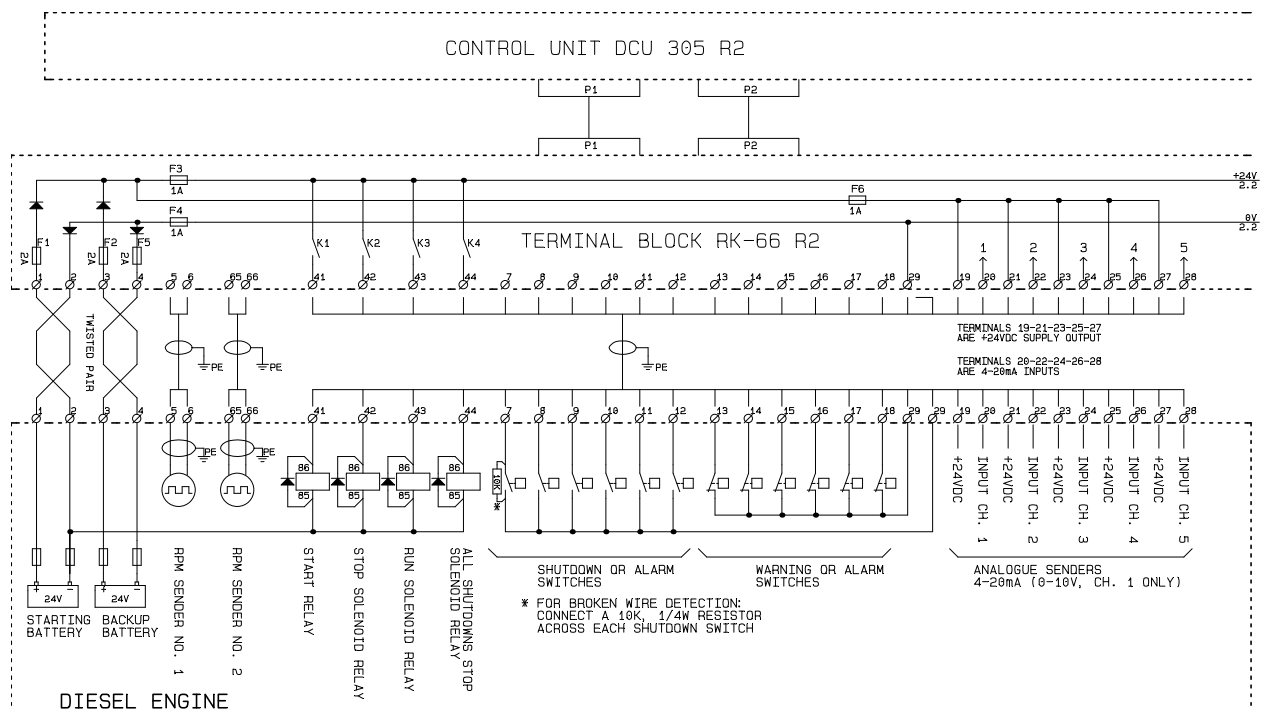
Function	Press
Retrieve the complete log with timestamped events. The log is uploaded with the last event first.	<ESC> + L
Retrieve all counters (running hours, etc)	<ESC> + C
Retrieve information (text that describes the installation/project)	<ESC> + I

The uploaded information can be stored on your laptop for future reference.

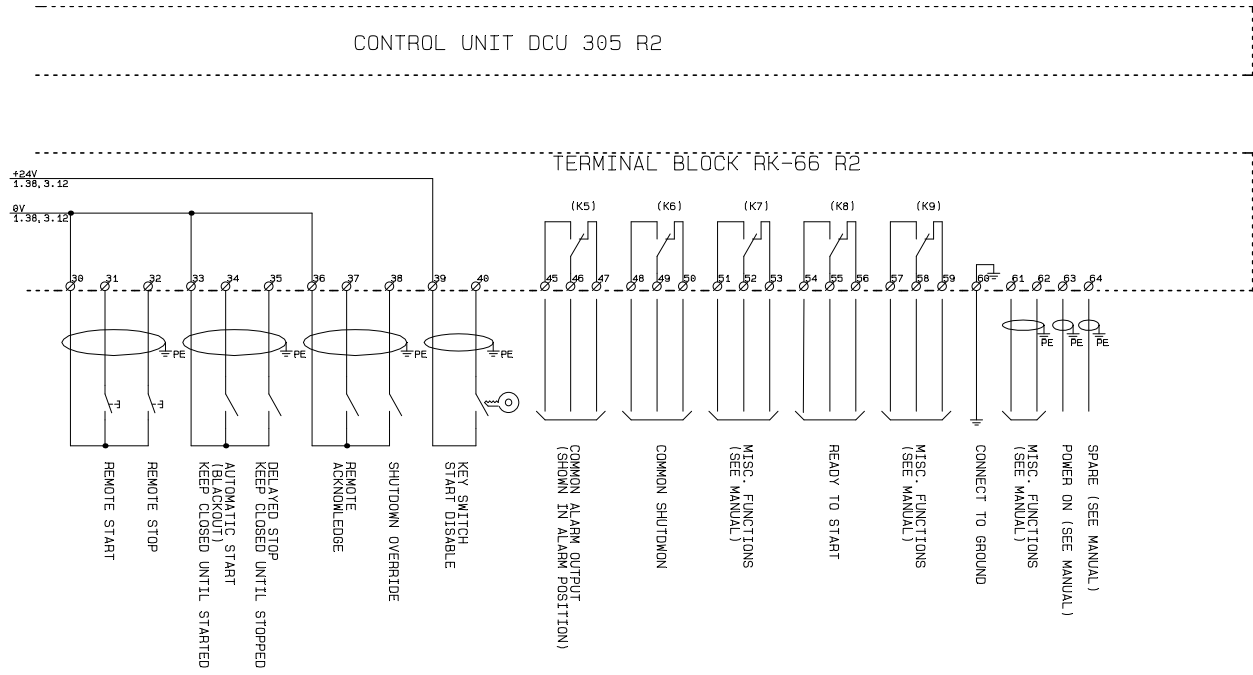


# Schematic Drawings

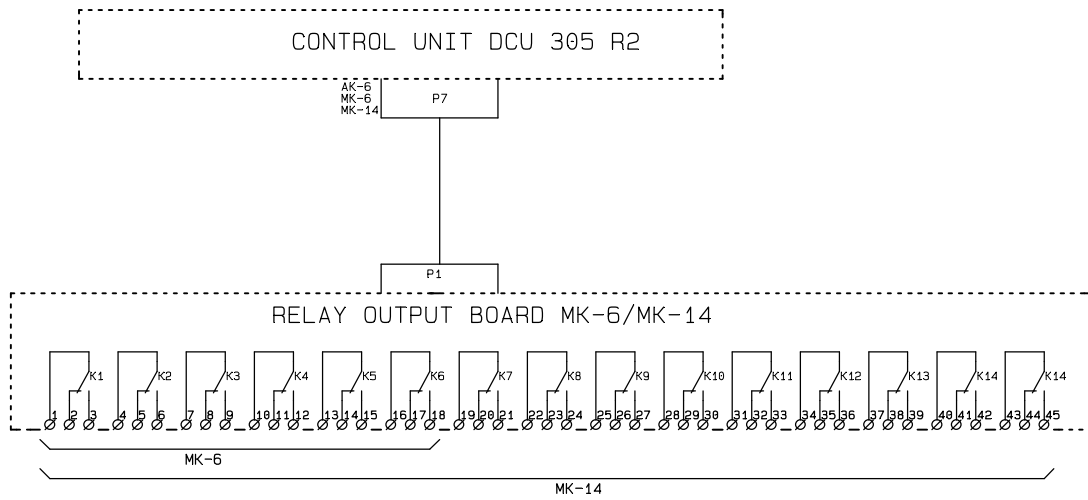
## Sample schematic page 1



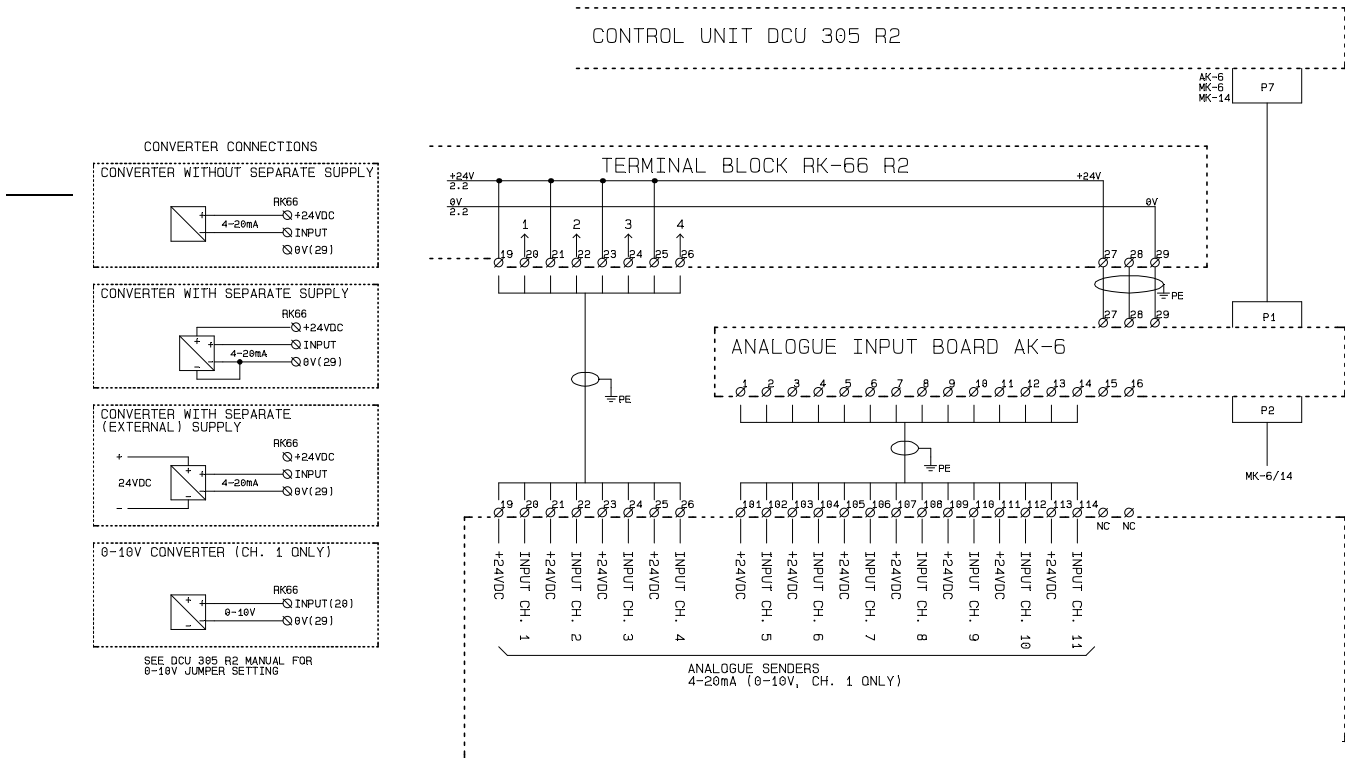
# Sample schematic page 2



# Optional relay card MK-6



# Optional analogue card AK-6



# Cable Specification

Terminal	Function	Cable specifications	Comment
1-2	Primary 24VDC supply	Twisted pair 1.5 mm <sup>2</sup>	
3-4	Secondary 24VDC supply	Twisted pair 1.5 mm <sup>2</sup>	
5-6	Pickup 1	Shielded cable 2 x 0.5 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to GND at both ends
7-18	Digital inputs	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
19-20	Analogue input 1	Shielded cable 0.5 mm <sup>2</sup> <i>Separate cable if used as 0-10VDC</i>	Shield to be connected to GND at both ends
21-29	Analogue input 2 - 5	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
30-32	Remote Start Remote Stop	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
33-35	Blackout Start Delayed Stop	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
36-38	Remote Acknowledge Shutdown Override	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
39-40	Remote Keyswitch	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
41-44	Relays for Start/Stop	Shielded cable 0.5 mm <sup>2</sup>	
45-59	Relay outputs	Unshielded cable max 2.5 mm <sup>2</sup>	
60	GND	Unshielded 2.5 mm <sup>2</sup> GND cable	Connect to noise-free earth. L<1m
61-62	Configurable inputs	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
63	External power-on	Shielded cable 0.5 mm <sup>2</sup>	Shield to be connected to GND at both ends
64	Spare input	-	Not in use
65-66	Pickup 2	Shielded cable 2x0.5 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to GND at both ends
DSUB P3	- Rudolf Configuration - Comli/Modbus communication	Shielded cable 0.20 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to DSUB housing at DCU 305 R2 end only
DSUB P7	AK-6, MK-6, MK-14, C1-C2-C3 cable Expansion port	Shielded cable 0.20 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to DSUB housing at DCU 305 R2 end only
DSUB P9	J1708, J1587	Shielded cable 0.20 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to DSUB housing at DCU 305 R2 end only
DSUB P10	CAN, J1939	Shielded cable 0.20 mm <sup>2</sup> <i>Separate cable</i>	Shield to be connected to DSUB housing at DCU 305 R2 end only

## Wire Terminal Table, RK-66 R2

#	DCU 305 R2 A	DCU 305 R2 P	Comment
1	+24V	+24V	Primary supply. Connect to start battery.
2	0V	0V	
3	+24V	+24V	Secondary supply. Connect to auxiliary supply.
4	0V	0V	
5	Pickup 1	Pickup 1	Used when one pickup only.
6	Pickup 1	Pickup 1	2.5 - 30Vpp.
7	Switch input 1	Switch input 1	Referenced to 0V, terminal 29
8	Switch input 2	Switch input 2	Referenced to 0V, terminal 29
9	Switch input 3	Switch input 3	Referenced to 0V, terminal 29
10	Switch input 4	Switch input 4	Referenced to 0V, terminal 29
11	Switch input 5	Switch input 5	Referenced to 0V, terminal 29
12	Switch input 6	Switch input 6	Referenced to 0V, terminal 29
13	Switch input 7	Switch input 7	Referenced to 0V, terminal 29
14	Switch input 8	Switch input 8	Referenced to 0V, terminal 29
15	Switch input 9	Switch input 9	Referenced to 0V, terminal 29
16	Switch input 10	Switch input 10	Referenced to 0V, terminal 29
17	Switch input 11	Switch input 11	Referenced to 0V, terminal 29
18	Switch input 12	Switch input 12	Referenced to 0V, terminal 29
19	+24V	+24V	Output, protected by fuse F6
20	Analogue input 1, 4-20mA	Analogue Input 1, 4-20mA	
21	+24V	+24V	Output, protected by fuse F6
22	Analogue Input 2, 4-20mA	Analogue Input 2, 4-20mA	
23	+24V	+24V	Output, protected by fuse F6
24	Analogue Input 3, 4-20mA	Analogue Input 3, 4-20mA	
25	+24V	+24V	Output, protected by fuse F6
26	Analogue Input 4, 4-20mA	Analogue Input 4, 4-20mA	
27	+24V	+24V	Output, protected by fuse F6
28	Analogue Input 5, 4-20mA	Analogue Input 5, 4-20mA	
29	0V	0V	Common 0V
30	0V	0V	Common 0V
31	Remote Start	Remote Start	Connect to terminal 30 to activate
32	Remote Stop	Remote Stop	Connect to terminal 30 to activate
33	0V	0V	Common 0V
34	Blackout Start	-	Connect to terminal 33 to activate

#	DCU 305 R2 A	DCU 305 R2 P	Comment
35	Delayed Stop	-	Connect to terminal 33 to activate
36	0V	0V	Common 0V
37	Remote Reset	Remote Reset	Connect to terminal 36 to activate
38	Shutdown Override	-	Connect to terminal 36 to activate
39	Keyswitch Start Disable	Keyswitch Start Disable	Connect a wire between terminal 39 and 40 to enable start. <sup>2</sup>
40	Keyswitch Start Disable	Keyswitch Start Disable	If the wire is removed, start is inhibited.  Set switch SW1 to jumper across terminal 39 and 40.
41	To Start Solenoid	To Start Solenoid	Relay K1.  +24V supply to auxiliary start relay
42	To Stop Solenoid, +24V	To Stop Solenoid, +24V	Relay K2.  +24V supply to auxiliary stop relay
43	To Run Solenoid, +24V	To Run Solenoid, +24V	Relay K3.  +24V supply to auxiliary run relay
44	To Shutdown Solenoid	To Shutdown Solenoid	Relay K4.  +24V supply to auxiliary shutdown solenoid.
45	Common Alarm, NO	Common Alarm, NO	Relay K5.  The Common <i>Alarm</i> relay.
46	Common Alarm, C	Common Alarm, C	
47	Common Alarm, NC	Common Alarm, NC	
48	Common Shutdown, NO	Common Shutdown, NO	Relay K6.  The common <i>Shutdown</i> relay.
49	Common Shutdown, C	Common Shutdown, C	
50	Common Shutdown, NC	Common Shutdown, NC	
51	K7, NO	Config relay, NO	Relay K7.
52	K7, C	Config relay, C	Configurable relay.
53	K7, NC	Config relay, NC	
54	Ready to Start, NO	Ready to Start, NO	Relay K8.
55	Ready to Start, C	Ready to Start, C	Activates when ready to start, and not in LOCAL mode or MANUAL mode.
56	Ready to Start, NC	Ready to Start, NC	
57	K9, NO	Config relay, NO	Relay K9.
58	K9, C	Config relay, C	Configurable relay.
59	K9, NC	Config relay, NC	
60	GND – chassis – hull	GND – chassis – hull	Connect to the hull.
61	Config input 1	Config input	Configurable input.
62	Config input 2	Config input	Configurable input.

<sup>2</sup> The wire terminal card has a switch (SW1) connected over terminal 39 and 40. The switch is accessible from underneath the rubber seal on top of the RK-66 R2 terminal card.

#	DCU 305 R2 A	DCU 305 R2 P	Comment
63	Power-on <sup>3</sup>	Power-on	Connect to +24V to power-on in parallel with the keyswitch found on DCU 305 R2 P.
64	Reserved input	Reserved input	For future expansion
65	Pickup 2	Pickup 2	For pickup 2.
66	Pickup 2	Pickup 2	Use Pickup 1 inputs if there is one pickup only. 2.5-30Vpp.

## Wire terminal table, relay card MK-6 and MK-14

The functions on these optional relays are user defined using the Rudolf configuration tool.

Relay	Terminal	Relay
K1	1	Relay 1, C
	2	Relay 1, NC
	3	Relay 1, NO
K2	4	Relay 2, C
	5	Relay 2, NC
	6	Relay 2, NO
K3	7	Relay 3, C
	8	Relay 3, NC
	9	Relay 3, NO
K4	10	Relay 4, C
	11	Relay 4, NC
	12	Relay 4, NO
K5	13	Relay 5, C
	14	Relay 5, NC
	15	Relay 5, NO
K6	16	Relay 6, C
	17	Relay 6, NC
	18	Relay 6, NO
K7	19	Relay 7, C
	20	Relay 7, NC
	21	Relay 7, NO
K8	22	Relay 8, C
	23	Relay 8, NC
	24	Relay 8, NO
K9	25	Relay 9, C
	26	Relay 9, NC

*MK-6 limit* →

<sup>3</sup> In the DCU 305 R2 A, this feature has no effect unless internal jumper J1 is removed.



Relay	Terminal	Relay
	27	Relay 9, NO
K10	28	Relay 10, C
	29	Relay 10, NC
	30	Relay 10, NO
K11	31	Relay 11, C
	32	Relay 11, NC
	33	Relay 11, NO
K12	34	Relay 12, C
	35	Relay 12, NC
	36	Relay 12, NO
K13	37	Relay 13, C
	38	Relay 13, NC
	39	Relay 13, NO
K14 #1	40	Relay 14, C1
	41	Relay 14, NC1
	42	Relay 14, NO1
K14 #2	43	Relay 14, C2
	44	Relay 14, NC2
	45	Relay 14, NO2

---

**Note:** Relay 14 has *two* changeover contacts.

---

## Wire terminal table, analogue card AK-6

Please note that when using the optional AK-6 card, analogue channel 5 is moved from the RK-66 to the AK-6 card.

Terminal	AI channel	Signal type
1	5	+24V supply
2	→	4-20mA input
3	6	+24V supply
4	→	4-20mA input
5	7	+24V supply
6	→	4-20mA input
7	8	+24V supply
8	→	4-20mA input
9	9	+24V supply
10	→	4-20mA input
11	10	+24V supply
12	→	4-20mA input
13	11	+24V supply
14	→	4-20mA input
15	-	NC
16	-	NC
27	*)	Connect to RK-66 terminal 27
28	*)	Connect to RK-66 terminal 28
29	*)	Connect to RK-66 terminal 29

\*) Connect these three wires between RK-66 R2 and AK-6.

# Appendix

## Ordering information

Article	Description	Comment
06400	<i>DCU 305 R2 A, Complete with wire terminal card RK-66R2 and cables</i>	Complete auxiliary/emergency unit
06401	<i>DCU 305 R2 P, Complete with wire terminal card RK-66 R2 and cables</i>	Complete Propulsion unit
06405	<i>DCU 305 R2 A CU Control unit only</i>	Main auxiliary/emergency unit only
06406	<i>DCU 305 R2 P CU Control Unit only</i>	Main propulsion unit only
75410	<i>RK-66 R2 Wire Terminal card</i>	The standard wire terminal card
75262	<i>MK-6 Relay Card with 6 relays, w/ 200cm cable</i>	Relay functions are configured using Rudolf
75263	<i>MK-14 Relay Card with 14 relays, w/ 200cm cable</i>	Relay functions are configured using Rudolf
75268	<i>AK-6 Analogue Card with six 4-20mA analogue input channels and 200cm cable</i>	Channels are configured using Rudolf
06500	<i>RSP 305 Remote Slave Panel with the look and feel of the DCU 305.</i>	<i>Configures itself automatically. For up to four DCU 305 units.</i>
08334	<i>PT100/1000/NICRNI – 4-20mA converter Configurable</i>	Converts signal into 4-20mA signal
09059	<i>Exhaust Temp monitoring, 8 cylinders</i>	Interfaced with the DCU 305 R2. Communicates with the slave panel.
09060	<i>Exhaust Temp monitoring, 12 cylinders</i>	Interfaced with the DCU 305 R2. Communicates with the slave panel.

Article	Description	Comment
09061	<i>Exhaust Temp monitoring, 16 cylinders</i>	Interfaced with the DCU 305 R2. Communicates with the slave panel.
75270	<i>Rudolf R2 Parameter Program Configuration tool</i>	Delivered on a CD (Manual included; article 09326)
75225	<i>Rudolf R2 configuration cable 200cm</i>	Cable has female D-SUB 9 connectors
09326	<i>Rudolf R2 User's Manual, English</i>	The configuration tool manual
06322	<i>DCU 305 R2 User's Manual, English</i>	User's Manual
06323	<i>DCU 305 R2 User's Manual, Norwegian</i>	User's Manual, native language
06324	<i>DCU 305 R2 Communication Manual</i>	For communication purposes
06325	<i>DCU 305 R2 Installation Manual</i>	This document

## Dec-to-Hex table

Use this table to configure the built-in backup system. Alternatively, use the values set by Rudolf.

Dec	Hex	Dec	Hex	Dec	Hex
1	01	28	1C	55	37
2	02	29	1D	56	38
3	03	30	1E	57	39
4	04	31	1F	58	3A
5	05	32	20	59	3B
6	06	33	21	60	3C
7	07	34	22	61	3D
8	08	35	23	62	3E
9	09	36	24	63	3F
10	0A	37	25	64	40
11	0B	38	26	65	41
12	0C	39	27	66	42
13	0D	40	28	67	43
14	0E	41	29	68	44
15	0F	42	2A	69	45
16	10	43	2B	70	46
17	11	44	2C	71	47
18	12	45	2D	72	48
19	13	46	2E	73	49
20	14	47	2F	74	4A
21	15	48	30	75	4B
22	16	49	31	76	4C
23	17	50	32	77	4D
24	18	51	33	78	4E
25	19	52	34	79	4F
26	1A	53	35	80	50
27	1B	54	36	81	51



Dec	Hex	Dec	Hex	Dec	Hex
82	52	132	84	182	B6
83	53	133	85	183	B7
84	54	134	86	184	B8
85	55	135	87	185	B9
86	56	136	88	186	BA
87	57	137	89	187	BB
88	58	138	8A	188	BC
89	59	139	8B	189	BD
90	5A	140	8C	190	BE
91	5B	141	8D	191	BF
92	5C	142	8E	192	C0
93	5D	143	8F	193	C1
94	5E	144	90	194	C2
95	5F	145	91	195	C3
96	60	146	92	196	C4
97	61	147	93	197	C5
98	62	148	94	198	C6
99	63	149	95	199	C7
100	64	150	96	200	C8
101	65	151	97	201	C9
102	66	152	98	202	CA
103	67	153	99	203	CB
104	68	154	9A	204	CC
105	69	155	9B	205	CD
106	6A	156	9C	206	CE
107	6B	157	9D	207	CF
108	6C	158	9E	208	D0
109	6D	159	9F	209	D1
110	6E	160	A0	210	D2
111	6F	161	A1	211	D3
112	70	162	A2	212	D4
113	71	163	A3	213	D5
114	72	164	A4	214	D6
115	73	165	A5	215	D7
116	74	166	A6	216	D8
117	75	167	A7	217	D9
118	76	168	A8	218	DA
119	77	169	A9	219	DB
120	78	170	AA	220	DC
121	79	171	AB	221	DD
122	7A	172	AC	222	DE
123	7B	173	AD	223	DF
124	7C	174	AE	224	E0
125	7D	175	AF	225	E1
126	7E	176	B0	226	E2
127	7F	177	B1	227	E3
128	80	178	B2	228	E4
129	81	179	B3	229	E5
130	82	180	B4	230	E6
131	83	181	B5	231	E7

<b>Dec</b>	<b>Hex</b>	<b>Dec</b>	<b>Hex</b>	<b>Dec</b>	<b>Hex</b>
232	E8	240	F0	248	F8
233	E9	241	F1	249	F9
234	EA	242	F2	250	FA
235	EB	243	F3	251	FB
236	EC	244	F4	252	FC
237	ED	245	F5	253	FD
238	EE	246	F6	254	FE
239	EF	247	F7	255	FF

<END>