5.7 Electronic control unit 48 V - controller

Krmilnik mora biti vgrajen na zaščiteno in suho mesto v plovilu ter ne sme biti izpostavljen vibracijam pogonskega diesel motorja ali pogonskega sklopa.

Vgrajena programska oprema krmilnika (software) zagotavlja delovanje funkcij hibridnega pogona.

The controller has to be installed to the protected and dry place in a boat and cannot be exposed to vibrations of a diesel engine or drive assembly.

Installed controller software ensures operation of all hybrid drive functions.

5.8 Data Display Interface (DDI)

5.8.1 Introduction

Podatkovni prikazovalnik DDI omogoča prikazovanje podatkov za nadzor načina delovanja in izmerjene vrednosti v elektronskem krmilniku HCU.

DDI prikazuje trenutni način delovanja sistema in HCU, napetost na bateriji, temperaturo in tok, stanje napolnjenosti baterije, vrtilno hitrost in temperaturo električnega motorja, šifre napak in druge podatke uporabne za serviserje.

DDI preklaplja med dvemi ali tremi različnimi ekrani glede na trenutni način delovanja. Vsak ekran je prikazan 20 sekund. Vsak preklop ekran ima še dodatno utripajočo led diodo, ki označuje spremembo.

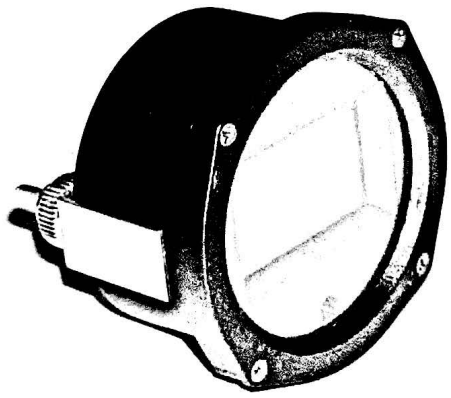
Vsi prikazani podatki so indikativni z natančnostjo ±5%.

Data Display Interface (shortly DDI) displays the information for monitoring the functions and measured values in the HCU (Iskra hybrid 48 V controller).

DDI shows the current working mode of the HCU, battery voltage, temperature and current, state of battery charging, speed and temperature of electric motor, error codes and also some other data useful only for service personnel.

DDI switches between 2 or 3 different screens depending on the current working mode. Each screen is shown for 20 seconds. The screen switching is additionally perceivable by toggling of LED light mounted on DDI cover.

All data have to be considered as indicative only, precision is ±5%.



DDI - Data Display Interface device

5.8.2 Hardware installation

DDI je priključen na hibridni pogon s 4-pinskim ženskim Molex konektorjem (slika spodaj)

Pogled označevanja pinov je iz zadnje strani

1 – CAN_LO (CAN low line)
2 – CAN_HI (CAN high line)
3 – GND (- napajanje)
4 – VCC (+ napajanje)

VCC mora biti priključen na +12 V glavnega tokokroga na čolnu.
GND mora biti priključen na maso glavnega tokokroga na čolnu.

CAN_HI mora biti priključen na pin številka 27 na HCU glavnem konektorju.
CAN_LO mora biti priključen na pin številka 28 na HCU glavnem konektorju.

Za zagotovitev zanesljivega delovanja sistema priporočamo uporabo kablov z oklopom za povezavo CAN_HI in CAN_LO. Oklop mora biti povezan na pin št. 29 na glavnem konektroju na HCU

DDI is connected to the hybrid system by 4-pin female Molex connector (see bellow).

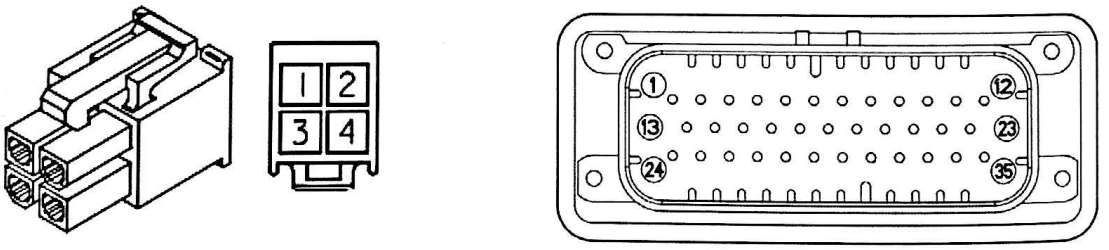
Connector pin number listing (rear view):

1 – CAN_LO (CAN low line)
2 – CAN_HI (CAN high line)
3 – GND (negative power supply)
4 – VCC (positive power supply)

VCC must be connected to +12 V voltage (boat main electric network)
GND must be connected to ground (boat main electric network)

CAN_HI must be connected to pin number 27 (HCU main connector)
CAN_LO must be connected to pin number 28 (HCU main connector)

For device reliable working the usage of shielded cable for wires CAN_HI and CAN_LO is highly recommended. Shielding must be connected to pin number 29 of HCU main connector.



A cross-view of 4-pin connector (on DDI device) and 35-pin connector (on HCU controller)

5.8.3 DDI screen's description

Na vsakem ekranu so štiri vrstice. Zadnja je skupna in je namenjena prikazu možnih napak v delovanju HCU.

All screens have four lines. A common fourth line is reserved for showing eventual errors, which can occur on HCU.

5.8.3.1 DDI Quick screen listing

	Data 1	Data 2
SCREEN 1		
Line 1	Mode	Motor temp.
Line 2	IG module temperature	AC module temperature
Line 3	Speed (RPM)	Battery temperature
Line 4	IG Errors	AC Errors
SCREEN 2		
Line 1	IG DC-link voltage	AC DC-link voltage
Line 2	Battery current	Motor current
Line 3	Battery voltage	Remaining Battery cap.
Line 4	IG Errors	AC Errors
SCREEN 3		
Line 1	Charging phase	Battery temperature
Line 2	Charging level	Final chg. level / absorption time
Line 3	Charging phase duration	Total charging duration
Line 4	IG Errors	AC Errors
SCREEN: Connection lost		
!!! HCU LOST !!		

The values shown in DDI are merely indicative.

Režim uporabe hibridnega sistema na plovilu moramo prilagoditi tako, da so prikazane vrednosti na DDI v mejah podanih okvirnih vrednosti pri normalni uporabi,ki so podane v naslednji tabeli.

The mode of operation of the hybrid system in the boat has to be adjusted so that all values shown in the DDI are within the limits of the frame value at the normal use, given in the next table.

	Data 1	Description	Data 1 normal range	Data 2	Description	Data 2 normal range
SCREEN 1 GREEN						
Line 1	*Mode*	Current working mode	N, FWD, G, GS, ERR	*MotT*	Motor temp.	From –10°C to 100°C
Line 2	*IG_T*	IG module temperature	From –10°C to 90°C	*AC_T*	AC module temperature	From –10°C to 90°C
Line 3	*RPM*	Speed (RPM)	0 to 1550	*Bat_T*	AGM battery temperature	From –10°C to 50°C
Line 4	*IG Errors*			*AC Errors*		
SCREEN 2 REO						
Line 1	*IG*	IG DC-link voltage	From 0 to 200V	*AC*	AC DC-link voltage	From 0 to 200V
Line 2	*Ib*	Battery current	From –100 to 140 A	*Imot*	Motor current	From –50 to 110 A
Line 3	*Vb*	Battery voltage	From 45 to 58V	*C*	Remaining Battery cap.	Only for lead-acid batteries
Line 4	*IG Errors*			*AC Errors*		
SCREEN 3 NONE						
Line 1	*x*	Charging phase	Lead–acid batteries: BULK, ABSRPT FLOAT, Li–PO batteries: ABSRPT	*Bat_T*	Battery temperature	From –10°C to 50°C
Line 2	*chL*	Charging level	from 0 to 255b		Final chg. level / absorption time	from 0 to 255b or from 0 to 9999 s
Line 3	*tPH*	Charging phase duration	from 0 to 9999s	*tTOT*	Total charging duration	from 0 to 9999 s
Line 4	*IG Errors*			*AC Errors*		
SCREEN: Connection lost						
	!!! HCU LOST !!					

5.8.3.2 SCREEN 1

Line 1, data 1: ***Mode: x***
Mode: x shows the current operation i.e. working mode of HCU unit.

'*x*' can be:

- **N** – neutral mode (only logic part of HCU is active)
- **FWD** – electric motor mode i.e. electric propulsion
- **G** – generator mode i.e. diesel engine active, HCU charges batteries
- **GS** – gear shifting mode i.e. a special mode active only during between changing of generator and electric mode
- **ERR** – error mode i.e. failure mode, which can become active in case of a malfunction, bad system connection, overloading, overheating, etc…

Line 1, data 2: ***MotT: xC***
MotT: xC indicates electric motor temperature in Celsius degree.

Line 2, data 1: ***IG_T: xC***
IG_T: xC indicates temperature of IG power module inside HCU unit.

Line 2, data 2: ***AC_T: xC***
AC_T: xC indicates temperature of AC power module inside HCU unit.

Line 3, data 1: ***RPM: x***
RPM: x indicates the speed of electric engine in ratio-per-minute (RPM) unit.

Line 3, data 2: ***Bat_T: xC***
Bat_T: xC indicates temperature of GEL or AGM batteries, if Li-PO batteries are used, then the value is forced to show always 25°C.

5.8.3.3 SCREEN 2

Line 1, data 1: ***IG xV***
IG: xV indicates HCU internal voltage on DC-link of IG part in 0.05V resolution.

Line 1, data 2: ***AC xV***
AC: xV indicates HCU internal voltage on DC-link of AC part in 0.05V resolution.

Line 2, data 1: ***Ib: xA***
Ib: xA indicates current flowing into / out of HCU battery terminals in 0.05A resolution. Sign '–' appears before the value when HCU charges batteries, i.e. during generator mode.

Line 2, data 2: ***Imot: xA***
Imot: xA indicates motor phase current of electric engine in 0.05A resolution.

Line 3, data 1: ***Vb: xV***
Vb: xV indicates battery voltage measured at HCU battery terminals in 0.05V resolution.

Line 3, data 2: ***C: xAh***
C: xAh indicates the remaining battery capacity in 0.05Ah resolution. This data is available only for lead–acid battery type. The shown value strongly depends on the battery type and is not accurate, due to the absence of battery current measurement. This value is inacurate if HCU parameters are not properly chosen.

5.8.3.4 SCREEN 3

The contents of the third screen strongly depends on the battery type used. AGM type batteries are charged with three-step charging method. Li–PO batteries are charged with a current limit - constant voltage method.

Line 1, data 1: *x*
x indicates the current state (phase) of the three-step charging method.

For lead-acid batteries '*x*' could be:

- **BULK** – bulk phase
- **ABSRPT** – absorption phase
- **FLOAT** – float phase

For Li–PO batteries '*x*' is forced to show ABSRPT.

Line 1, data 2: *Bat_T: xC*
Bat_T: xC indicates temperature of GEL or AGM batteries, if Li–PO batteries are used, then the value is forced to always show 25°C.

Line 2, data 1: *chL: xb*
chL: xb indicates current charging voltage level in 1b (bit) resolution. If AGM batteries are used (and current phase is BULK), then this value gradually approaches to the final value (shown in line 2, data 2). Variation speed of this value depends on the battery state-of-charge and on charging current amplitude. If Li–PO battery is used, then the value depends on the desired (constant) charging voltage.
The range of shown data goes from 0 to 255b.

Line 2, data 2
The meaning of this data depends on the current state of the three-step charging method.

If the current charging state is BULK (only for AGM batteries), then this data shows *chLD: xb*, which means the final (desired) charge level. The value '*x*', in 1b (bit) resolution, is calculated considering battery temperature.
The range of shown data goes from 0 to 255b.

If the current charging state is ABSRPT or FLOAT, then this data shows *tABS: xs*, which means the expected duration of the absorption phase in 1s (second) resolution. The value '*x*' is calculated considering the duration of the BULK phase.
The range of the shown data goes from 0 to 9999s.

Line 3, data 1: ***tPH :xs***
tPH :xs indicates the current charging phase progress (i.e. how long HCU works in the current phase), in seconds.
The range of the shown data goes from 0 to 9999s. The actual value (in BULK or FLOAT phase) can exceed the maximum value. In this case, the displayed value is not correct anymore.

Line 3, data 2: ***tTOT :xs***
tTOT :xs indicates the duration of the total charging progress (i.e. how long HCU operates in the charging mode), in seconds.
The range of the shown data goes from 0 to 9999s. The actual value can exceed the maximum value. In this case, the displayed value is not correct anymore.

5.8.3.5 ERROR LINE

The fourth line is reserved for showing potential errors of both controllers inside HCU. More than 1 error can occur at the same time; consequently the values are displayed as 2 HEX bytes to simplify error recognition. Single bit (error flag) has default value '0', and changes to '1', if a corresponding error occurs. The errors are shown until the cause of the failure persists, and then are automatically cleared.

Line 4, data 1: ***IG_E:x***
IG_E:x indicates the errors which occurred in "IG" controller part. Only low byte is used, the high byte is unused and left for future error listing expansion.

Line 4, data 2: ***AC_E:x***
AC_E:x indicates the errors which occurred in the "AC" controller part.

5.8.3.6 AC Error listing (HEX code):

Error Code	Error Name	Consequence	Reason	Action	Note
0x0000	No error	/	/	/	
0x0001	DC_link over voltage	ERROR mode	DC_link voltage exceeded 270 V	Wait for DC_link voltage drop	1
0x0002	*Not significant*	/	/	/	
0x0004	Generator over voltage	Charging interrupted	Battery voltage exceeded 53,6 V	Wait for battery voltage drop	2
0x0008	*Not significant*	/	/	/	
0x0010	Propulsion under voltage	El. propulsion interrupted	Battery discharged	Recharge battery	
0x0020	Power module warm	Power reduction	Power module temperature above 85°C	Reduce speed Check water cooling	
0x0040	Power module excessive hot	ERROR mode	Power module temperature above 95°C	Stop Check water coolingx	
0x0080	Over current HW	Power reduction	Phase current exceeded maximum limit	Reduce speed	
0x0100	Battery hot	ERROR mode	Battery temperature exceeded maximum limit	Stop Battery must cool	3
0x0200	Hall sensor	Permanent ERROR mode	Damaged hall sensors	Service needed	
0x0400	CAN lost	Permanent ERROR mode	CAN Communication with IG part interrupted	Service needed	4
0x0800	*Not significant*	/	/	/	
0x1000	Actuator fail	Permanent ERROR mode	Actuator failed to switch position within 6 s	Check actuator / Service needed	
0x2000	Over speed	El. propulsion interrupted	Rotational speed in electric propulsion exceeded maximum limit	Wait for motor speed stabilisation	
0x4000	Motor over heat	Warning	Motor temperature above 112°C	Reduce speed	
		Power reduction	Motor temperature above 115°C	Check water cooling	
		ERROR mode	Motor temperature above 120°C	Stop Check water cooling	
0x8000	High battery current	Possible overload	Battery current exceeded maximum limit	Reduce speed	

ERROR mode means Electric propulsion and Generator mode (HCU charging) are disabled.

Permanent ERROR mode means Electric propulsion and Generator mode (HCU charging) are permanently disabled. The customer shall first try to **re–start the hybrid system**. Switch off circuit breaker *48 V Hybrid drive*. Wait 10sec and then switch on circuit breaker *48 V Hybrid drive*. If the problem persists, hybrid system service is required.

More than 1 error can sometimes occur at the same time. Therefore HEX arithmetic shall be used to decode error types in such cases. For example error number 0x0291 means that errors 0x0200, 0x0080, 0x0010 and 0x0001 occurred.

Note 1:
DC_link over voltage error shall not be understood as an error when battery voltage is between 53,6 V and 54 V and HCU operates in Generator mode.
Note 2:
Generator over voltage error shall not be understood as an error. It is a signalization that battery reached the maximum voltage 53,6 V and therefore HCU stopped charging.
Note 3:
Battery hot error is valid only for system with AGM batteries.
Note 4:
CAN lost error: In such case, the customer shall first try to re–start the hybrid system. If the problem persists, hybrid system service is required.

5.8.3.7 IG Error listing (HEX code):

Error Code	Error Name	Consequence	Reason	Action	Note
0x0000	No error	/	/	/	
0x0001	DC_link over voltage	ERROR mode	DC_link voltage exceeded 270 V	Wait for DC_link voltage drop	1
0x0002	Power module warm	Power reduction	Power module temperature above 85°C	Reduce speed Check water cooling	
0x0004	Power module hot	Increased power reduction	Power module temperature above 90°C	Reduce speed Check water cooling	
0x0008	Power module excessive hot	ERROR mode	Power module temperature above 95°C	Stop Check water cooling	
0x0010	Step up under voltage	El. propulsion intermittent / stopped	Battery voltage below 42 V	Recharge battery	
0x0020	Bad power module	Possible malfunction or failure	Damaged power module	Service needed	
0x0040	CAN lost	Permanent ERROR mode	CAN Communication with AC part interrupted	Service needed	4
0x0080	Battery over voltage	ERROR mode	Battery voltage exceeded 61 V	Check battery and all charging systems	

ERROR mode means Electric propulsion and Generator mode (HCU charging) are disabled.

Permanent ERROR mode means Electric propulsion and Generator mode (HCU charging) are permanently disabled. The customer shall first try to **re–start the hybrid system**. Switch off circuit breaker *48 V Hybrid drive*. Wait 10sec and then switch on circuit breaker *48 V Hybrid drive*. If the problem persists, hybrid system service is required.

More than 1 error can sometimes occur at the same time. Therefore HEX arithmetic shall be used to decode error types in such cases. For example error number 0x0291 means that errors 0x0200, 0x0080, 0x0010 and 0x0001 occurred.

Note 1:
DC_link over voltage error shall not be understood as an error when battery voltage is between 53,6 V and 54 V and HCU operates in Generator mode.
Note 4:
CAN lost error: In such case, the customer shall first try to re–start the hybrid system. If the problem persists, hybrid system service is required.

5.8.3.8 SCREEN: Connection lost

If AC controller part inside HCU loses communication with IG part for more than 3 s, then the following message appears: **"!!! HCU LOST !!!"**. The user must try to re-establish normal HCU operation with power reset. This is done by switching off the diesel engine and setting the main switch of 48 V battery to **OFF.** After that, the user should restart the hybrid system. If the problem persists or arises very frequently, there is a high possibility that hardware inside HCU is damaged or wiring has become loosened.