IEC/IEEE 80005-2

Edition 1.0   2016-06

INTERNATIONAL
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colour inside

**Utility connections in port –
Part 2: High and low voltage shore connection systems – Data communication
for monitoring and control**

**Alimentation des navires à quai –
Partie 2: Systèmes de connexion à quai à haute et basse tensions – Description
de l'interface de communication de données dédiées au suivi et contrôle**

IEC/IEEE 80005-2:2016-06(en-fr)

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UTILITY CONNECTIONS IN PORT –

**Part 2: High and low voltage shore connection systems –
Data communication for monitoring and control**

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It is published as a triple logo (IEC, ISO and IEEE) standard.

The text of this standard is based on the following IEC documents:

FDIS	Report on voting
18/1490/FDIS	18/1495/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

International standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

Texts in italics in this standard are for signals of the data packets.

A list of all parts in the IEC 80005 series, published under the general title *Utility connections in port*, can be found on the IEC website.

The IEC Technical Committee, the ISO Subcommittee and the IEEE Technical Committee have decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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1   A list of IEEE participants can be found at the following URL:
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INTRODUCTION

Onshore power supply systems need communication between the ship side and the shore side. Different kinds of communication have to be distinguished, see Clause 3.

This Part 2 of IEC/IEEE 80005 series deals with the non-safety related communication. It covers the requirements of the HVSC systems described in Part 1 and is also intended to cover the requirements of a forthcoming standard for LV shore connection systems.

UTILITY CONNECTIONS IN PORT –

**Part 2: High and low voltage shore connection systems –
Data communication for monitoring and control**

1 Scope

This part of IEC/IEEE 80005 describes the data interfaces of shore and ships as well as step by step procedures for low and high voltage shore connection systems communication for non-emergency functions, where required. This standard specifies the interface descriptions, addresses and data type. This standard also specifies communication requirements on cruise ships, in Annex A.

Application of this standard relates to annexes of IEC/ISO/IEEE 80005-1.

This standard does not specify communication for emergency functions as described in IEC/ISO/IEEE 80005-1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/ISO/IEEE 80005-1:2012, *Utility connections in port – Part 1: High Voltage Shore Connection (HVSC) Systems – General requirements*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in IEC/ISO/IEEE 80005-1, as well as the following apply.

**3.1
communication for emergency function**
hard wired signals that trip the feeding circuit breakers (ship side and shore side)

**3.2
communication for non-emergency function**
data exchange between shore and the ship for informational purposes

Note 1 to entry: If such data exchange requires tripping of the circuit breaker it will also be communicated via the pilot loop.

**3.3
register**
16 bit location for storing data

**3.4
High Byte
HB**
high byte of a register, the leftmost eight bits

3.5
Low Byte
LB
low byte of a register, the rightmost eight bits

3.6
big endian format
High Byte is stored firstly in the memory, Low Byte in a subsequent position

3.7
Most Significant Bit
MSB
leftmost bit

3.8
Least Significant Bit
LSB
rightmost bit

3.9
bypass key
keyed selector switch that allows data communication to be switched on or off

3.10
alarm
activation of an event that shows a critical state

3.11
warning
announcing a situation or condition requiring attention but no-immediate attention or action and presented for precautionary reasons to make personnel aware of changed conditions which are not immediately hazardous, but may become so, if no forward-looking decision is made or action is taken

3.12
Co
command

3.13
ESD-1
emergency shutdown initiated when the ship moves past the warning range of allowable motion forward, aft or outward from the dock, and which initiates an LNG ship – ESD signal from shore to ship

3.14
ESD-2
emergency shutdown initiated when the ship moves past the maximum range of allowable motion forward, aft or outward from the dock, and which initiates loading arm disconnection on shore

4 General

4.1 Power connection single line diagram

Figure 1 shows the connection cables with the designation of the main switches used in this standard.
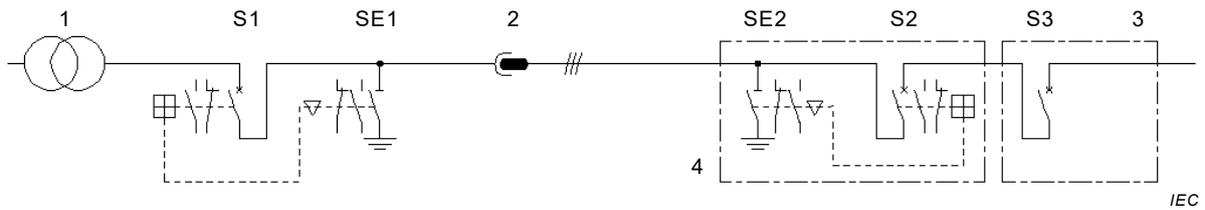
Key

1   Shore side transformer

S1   Shore side circuit breaker

SE1   Shore side earthing switch, for HVSC only

2   Cable connection with plugs (single or parallel cables)

SE2   Onboard shore connection switchboard earthing switch, for HVSC only

S2   Onboard shore connection switchboard circuit breaker

S3   Onboard receiving switchboard connection point circuit breaker (synchronizing switch)

3   Onboard receiving switchboard

4   Onboard shore connection switchboard

Figure 1 – Power connection single line diagram

4.2   Data communication diagram

Figure 2 shows the general diagram of the data communication system used in this standard.
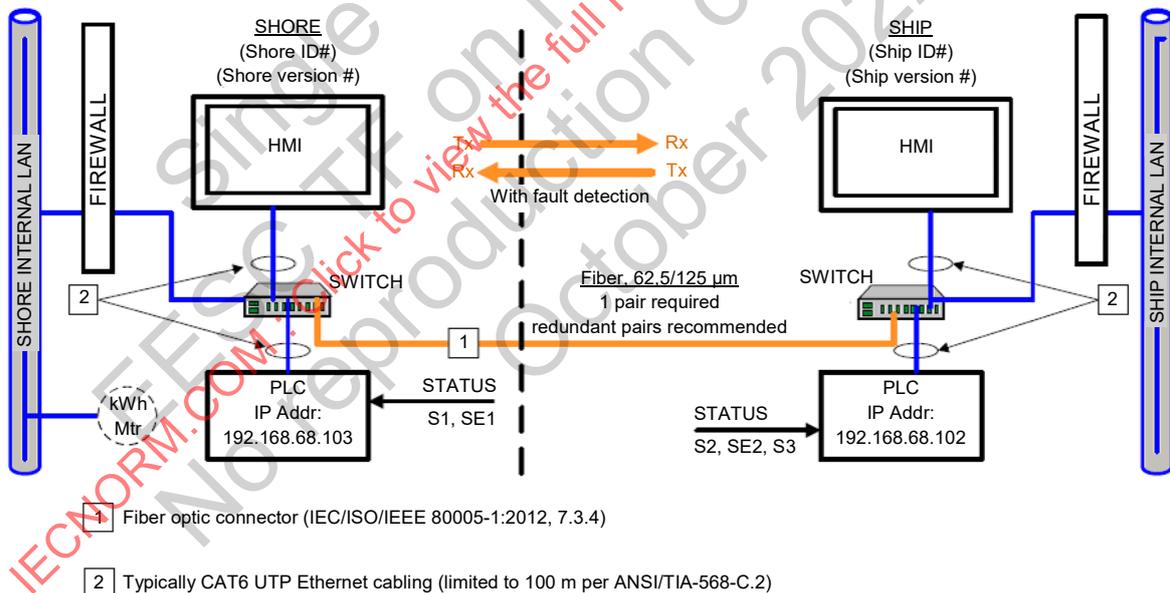
1   Fiber optic connector (IEC/ISO/IEEE 80005-1:2012, 7.3.4)

2   Typically CAT6 UTP Ethernet cabling (limited to 100 m per ANSI/TIA-568-C.2)

NOTE Assign HMI IP addresses on ship less than 192.168.68.102, on shore greater than 192.168.68.103

Figure 2 – Data communication general diagram

4.3   Physical layer

The connection of the communication control unit onshore to offshore is a point to point connection, see 7.3.4., A.2.7 of IEC/ISO/IEEE 80005-1:2012, except as noted in A.4.1 for cruise ships.

4.4 Protocol and IP-address

The ModbusTCP/IP protocol is specified for the communication between shore and ship.

The shore side polls the ship side with every cycle of the communication module (as fast as possible) with a single Modbus data packet request of 125 registers. The content of the data packet is specified in Clause 6.

The ship side also polls the shore side with every cycle of the communication module (as fast as possible) with a single Modbus data packet request of 125 registers. The content of the data packet is specified in Clause 5.

Both the shore side and the ship side will make the requests with a single Holding Register Block Read utilizing Modbus function code 0x03 with the Modbus Unit ID.

It is required that both shore side and ship side have a dedicated and reserved data block to make available information for the other side. This data block starts at the absolute register address 0 and is 125 registers long. Data blocks registers configuration shall be as described in Clauses 5 and 6 and Annex A and Annex B.

It is required that both shore side and ship side have a fixed IP address and port number for the communication via ModbusTCP/IP. In order to avoid any IP address conflict, the communication between shore side and ship side shall be on a dedicated network (other IP devices are not allowed). IP addresses and port numbers are specified as follows:

- IP-Address shore side: 192.168.66.103
- Subnet mask: 255.255.255.0
- Port number shore side: 502
- IP-Address ship side: 192.168.66.102
- Subnet mask: 255.255.255.0
- Port number ship side: 502

5   Interface shore

5.1   Shore: version number

The compatibility of the shore side may be checked on the basis of the version number high register, see Table 1.

Table 1 – Checking of compatibility of the shore side

Register	Bit	Description
0	0-7	*Shore Version Number LB* *Shore Version Number LB* identifies the interface version related to this standard (edition number of the standard), with data quantity and addresses of the data packet for which the running software was designed.
0	8-15	*Shore Version Number HB* *Shore Version Number HB* identifies the version number of the manufacturer-specific shore side software.
NOTE E.g. for edition number of the standard: 10 = 80005-2 ed. 1 and 20 = 80005-2 ed. 2 and 30 = 80005-2 ed. 3.		

5.2 Shore communication fault detection register

The communication validity shall be confirmed by the periodic change of the value of this register, additionally of existing diagnostic of communication functions, see Table 2.

Table 2 – Detection of communication fault

Register	Bit	Description
1	*n*	*Shore communication fault detection register* The value of *Shore communication fault detection register* is incremented every second.

5.3 Shore operation modes

5.3.1 Basic operation modes

The basic operation modes indicate in which procedure and state the shore side is actually working. Only one mode out of the basic modes may be active at the same time, see Table 3.

Table 3 – Basic operation modes

Register	Bit	Description
2	0	*Shore Mode Start Up* Shore system is in start up procedure. Ship may start shore side. For details see Clause 7.
2	1	*Shore Mode Running* Shore has closed all circuit breakers and opened all earthing switches. System is powered, synchronized and is ready to transfer load.
2	2	*Shore Mode Stop* This includes ESD-1 signal, see IEC/ISO/IEEE 80005-1. Shore is in Stop procedure. For details see Clause 8. At the end of *Shore Mode Stop* system changes to *Shore Mode Standby*.
2	3	*Shore Mode Emergency Stop* This includes ESD-2 signal, see IEC/ISO/IEEE 80005-1. Shore is in emergency stop. The following actions are automatically executed: • The pilot loop is opened immediately. • The circuit breaker S1 is opened immediately After opening of the circuit breaker S1 the earthing switch SE1 may be closed, see 4.9 of IEC/ISO/IEEE 80005-1:2012. A reset of the system is required. The *Shore Mode Emergency Stop* is set if one of the following conditions is fulfilled: • Emergency stop button onshore is pressed • One alarm on shore is set • Emergency stop button onboard is pressed • One alarm on ship is set • Communication fault detection register error is detected and bypass key onshore is not in "on" position and shore is not in *Shore Mode Running*. Pilot loop is opened immediately and shore is in *Shore Mode Emergency Stop* The *Shore Mode Emergency Stop* is reset after the activating condition is eliminated, CB S1 is open, SE1 is closed and the system is acknowledged. After this acknowledgement the system changes to *Shore Mode Standby*.
2	4	*Shore Mode Standby* Shore is in standby, only system warnings, alarms and status information are monitored. If no warning is active and the switches are in initial position (CB S1 open, SE1 closed) the system is ready for start up.

5.3.2 Optional operation mode cable test

The optional operation mode cable test indicates that the shore connection system is in the procedure to perform a cable test, see Table 4. (Shore will power the cable with nominal voltage but reduced power.)

Table 4 – Optional operation mode cable test

Register	Bit	Description
2	8	*Shore Mode Optional Cable Test* Shore system is actually in the procedure for cable test. Mode is set as feedback signal for ship command *Ship Co Test Cable* (see 6.7). Mode is reset after performed cable test and required switching operations. For details see 7.2.5.

5.3.3 Operation modes synchronization

The synchronization operation mode indicates for which type of synchronization the shore side is prepared according to the choice of the ship (see 7.2.3 and 7.2.6, and IEC/ISO/IEEE 80005-1:2012), see Table 5. Only one mode out of the synchronization modes may be active at the same time.

Table 5 – Operation modes synchronization

Register	Bit	Description
3	0	*Shore Mode Synchronization A1* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the ship side synchronizes to the shore side and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.2).
3	1	*Shore Mode Synchronization A2* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the shore side synchronizes to the ship side controlled from the ship and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.3).
3	2	*Shore Mode Synchronization A3* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the shore side synchronizes to the ship side and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.4).

5.3.4 Operation mode fault

The special fault mode indicates an overcurrent situation to the ship under different conditions, see Table 6.

Table 6 – Operation mode fault

Register	Bit	Description
3	8	*Shore Mode Clear Fault* In case of an overcurrent the clear fault mode is active, if all ship generators are off (see 6.8.4). If the overcurrent is present longer than application requested the shore side trips (*Shore Mode Emergency Stop*).
3	9	*Shore Mode No Clear Fault* In case of an overcurrent the no clear fault mode is active, if at least one ship generator is connected to the ships grid (see 6.8.4). Ship shall reduce power. If the overcurrent remains the shore side trips (*Shore Mode Emergency Stop*).

5.4 Alarms

The alarms indicate a critical condition onshore, which trips the shore and ship system, see Table 7. The ship side identifies and displays the information to the operator. The alarm is set if a basic subsystem (transformer, protection relay or converter) gives an alarm signal. Alarms are deactivated as soon as the monitored system returns to normal operating conditions and, if required, additionally acknowledgement on the subsystem. Additional special alarms may be indicated in the *Shore Summary Alarm* (see 5.8.1), but these alarms are not specified in detail within this data block. The ship side will trip after receiving of an alarm (via pilot loop and this interface). If the fault or the alarm is active, the bit is set to 1.

Table 7 – Shore alarms

Register	Bit	Description
5	0	*Shore Alarm Converter High Temperature*
5	1	*Shore Alarm Converter Leakage*
5	2	*Shore Alarm Converter Liquid Conductivity*
5	3	*Shore Alarm Transformer High Temperature*
5	4	*Shore Alarm Transformer Leakage*
5	5	*Shore Alarm Circuit Breaker Protection*
5	6	*Shore Alarm Cable Length*
5	7	*Shore Alarm Cable Mechanical Tension*
5	8	*Shore Alarm ESD2*
6	0	*Shore Alarm shore circuit-breaker protection overcurrent*
6	1	*Shore Alarm shore circuit-breaker protection overvoltage*
6	2	*Shore Alarm shore circuit-breaker protection undervoltage*
6	3	*Shore Alarm shore circuit-breaker protection reverse power*
6	4	*Shore Alarm Neutral Earthing Resistor Integrity*
6	5	*Shore Alarm shore circuit-breaker protection connectors*

5.5 Warning

The warnings indicate a critical condition onshore, which will not trip the shore or ship system, see Table 8. If a warning is active in standby mode it is not possible to initialize the start up procedure. The ship side identifies and displays the information to the operator. The warning is set, if a subsystem (transformer, UPS-battery or converter) gives a warning signal. Warnings are deactivated as soon as the monitored system returns to normal operating conditions. Additional warnings may be indicated in the *Shore Summary Warning* (see 5.8.1), but these warnings are not specified in detail within this data block. If the fault or the warning is active, the bit is set to 1.

Table 8 – Shore warnings

Register	Bit	Description
7	0	*Shore Warning Protection System Battery Charging Failure*
7	1	*Shore Warning Converter High Temperature*
7	2	*Shore Warning Converter Liquid Conductivity*
7	3	*Shore Warning Transformer High Temperature*
7	4	*Shore Warning Cable Length*
7	5	*Shore Warning Cable Mechanical Tension*
7	6	*Shore Warning ESD1*

5.6 Status of switches

The information block status of switches shows the state of all involved circuit breakers, earthing and auxiliary switches, see Table 9. If not open and not closed, then switch is considered in intermediate position.

Table 9 – Shore status of switches

Register	Bit	Description
9	0	*CB S1 Open*
9	1	*CB S1 Closed*
9	2	*Earth Switch SE1 Open*
9	3	*Earth Switch SE1 Closed*
9	8	*Shore Emergency Stop Button* The signal indicates that at least one emergency stop button is pressed. As long as the emergency stop button is not released the system cannot be acknowledged.

5.7 Optional commands

Shore commands are used to send requests to the ship side (see 7.2.5.1), see Table 10. A signal change 0→1 is required for every command at the specified step. The command signal shall be maintained until the feedback signal is received.

Table 10 – Shore commands

Register	Bit	Description
10	12	Reserved for optional *Shore Co Switch To Test Position* Shore indicates the ship to switch to the test position for cable test. Test position means open circuit breaker S3 and earthing switch SE2 and circuit breaker S2 in isolated position. The command will be set after a cable test was requested by the ship (see 6.7). Feedback signal from ship is *Ship Switched To Test Position* (see 6.8.2.4).

5.8 Status and diagnostic

5.8.1 General status and diagnostic

Shore general status and diagnostic data block includes summary signals and overall signals for the complete system, see Table 11.

Table 11 – Shore general status and diagnostic

Register	Bit	Description
12	0	*Shore No Fault* If the system is free of every alarm and warning this signal is set. With appearance of an alarm or warning the signal is reset.
12	1	*Shore Fault* *Shore Fault* is the inverted signal of *Shore No Fault* for safety reasons. *Shore Fault* is the summary signal for *Shore Summary Alarm* and *Shore Summary Warning* from shore side.
12	2	*Shore Summary Alarm* The signal is a summary signal for all alarms (see 5.4) and in addition for further additional system alarms, which are not listed in the alarm data block. The *Shore Summary Alarm* is reset as soon as the system is free of every alarm. Ship and Shore side will automatically perform an emergency stop.

12	3	*Shore No Summary Alarm*
		Shore No Summary Alarm is the inverted signal of *Shore Summary Alarm* for safety reasons.
12	4	*Shore Summary Warning*
		The signal is a summary signal for all warnings (see 5.5) and in addition for further additional system warnings, which are not listed in the warning data block. The *Shore Summary Warning* is reset as soon as the system is free of every warning.
12	5	*Shore Warning: Reduce Power*
		The shore side identifies the requirement to reduce the power (for example overcurrent). Shore indicates this requirement to ship and ship shall reduce power consumption. Signal is reset as soon as the power consumption is in permitted range.
12	6	*Shore Different Interface Version*
		This signal is set, if shore identifies different version numbers *(Shore Version Number LB* and *Ship Version Number LB)* for the interface version between shore and ship (see 5.1 and 6.1).
12	7	*Shore Interface Version Is Compatible*
		This signal is set, if the installed software on shore is able to handle the detected interface Version (*Ship Version Number LB*) of the ship. The signal is only set if a different interface version between shore and ship is detected and ship has a lower version number than shore side.

5.8.2 Special start up status and diagnostic

5.8.2.1 General

These data blocks include feedback signals for ship commands and indicate the current shore procedure step (see 7.2).

5.8.2.2 Status and diagnostic / droop values

The following data block includes signals for the subprocedure choice droop values (see 7.2.2 and Table 12).

Table 12 – Shore status and diagnostic/ droop values

Register	Bit	Description
14	0	*Shore Droop Values Possible*
		The signal indicates that shore is able to adapt droop values.
14	2	*Shore Droop Values Valid*
		The signal is set as soon as the droop values in the data block are valid (see 5.10 and 7.2.2). The signal shall be reset with the following signals from ship: *Ship Droop Values Accepted*, *Ship Droop Values Not Accepted* or *Ship Droop Values Skip*.
14	6	*Shore Droop Values Done*
		Shore Droop Values Done indicates the end of the subprocedure choice droop values. The signal is reset at the end of the start up procedure.

5.8.2.3 Status and diagnostic / choice power and synchronization

The following data block includes signals for the subprocedure choice power and synchronize mode (see 7.2.3 and Table 13).

Table 13 – Shore status and diagnostic/ choice power and synchronization

Register	Bit	Description
15	1	*Shore Power Choice Possible* Shore sets the signal after ship has done the choice of the power (see 7.2.3). The signal is reset with the end of the start up mode.
15	2	*Shore Power Choice Not Possible* Shore sets the signal after ship has done a not valid power choice (see 7.2.3). The signal is reset with the end of the start up mode (Stop command from ship) or with a valid power choice (see 6.9).
15	3	*Shore Synchronizing Mode Possible* Shore sets the signal after ship has done a valid choice of the synchronize mode (see 7.2.3). The signal is reset with the end of the start up mode or with a new invalid choice of the synchronize mode (see 6.7).
15	4	*Shore Synchronizing Mode Not Possible* Shore sets the signal after ship has done a not valid choice of the synchronize mode (see 7.2.3). The signal is reset with the end of the start up mode (Stop command from ship) or with a new valid choice of the synchronize mode (see 6.7).

5.8.2.4　Status and diagnostic / start of power

The following data block includes signals for the subprocedure Start of Power (see 7.2.4 and Table 14).

Table 14 – Shore status and diagnostic/ start of power

Register	Bit	Description
16	0	*Shore Ready For Start* Shore sets the signal after ship has done the choice of power and synchronize mode (see 7.2.3). The signal is reset with the end of the start up mode.
16	1	*Shore Power Is Starting* If the power choice is done and the shore system is ready for start, the ship may initialize the start of the power. The signal *Shore Power Is Starting* is set as feedback signal for ship command *Ship Co Start Shore Power* (see 6.7). The signal is reset with the end of the start up procedure. Shore opens the earthing switch SE1.

5.8.2.5　Status and diagnostic / optional cable test

This data block includes signals for ship indicating in which work step the shore is actually active within the cable test procedure (see 7.2.5 and Table 15).

Table 15 – Shore status and diagnostic/ optional cable test

Register	Bit	Description
17	0	*Shore Cable Test Possible* Shore signal indicate that shore is able to execute the cable test
17	1	*Shore Cable Test Ready* Precondition is that choice of power and synchronize mode was performed successfully (see 7.2.3). Furthermore the start of power subprocedure (see 7.2.4) is finished and the *Ship Permission To Close Shore CB* was received. The *Shore Cable Test Ready* is set from shore to indicate the ship to choose *Ship Co Test Cable* or *Ship Co No Cable Test* (see 6.7). The signal is reset with the end of the cable test procedure.
17	2	*Shore Cable Test Running* The signal is active while the cable test is running.

17	3	*Shore Cable Test Ok*
		At the end of the cable test the signal is set, if the test was successful. The signal is reset with the end of the start up procedure.
17	4	*Shore Cable Test Not Ok*
		At the end of the cable test the signal is set, if the test was not successful. The signal is reset with the end of the start up procedure (Stop command from ship).
17	5	*Shore Cable Test End*
		If the test was performed or waived and all required switching operations are done the signal is set. The signal is reset with the end of the start up procedure.

5.8.2.6   Status and diagnostic / synchronization

This data block includes signals for the subprocedure Synchronization (see 7.2.6 and Table 16).

Table 16 – Shore status and diagnostic/ synchronization

Register	Bit	Description
18	0	*Shore Permission To Close Ship CB*
		Only in case that synchronize mode A3 was chosen the signal is set as feedback signal for the work step information *Ship Ready To Close CB S3* (see 6.8.2.5). With the sending of this signal shore requests ship to close CB S3. The signal is reset with the end of the start up procedure. For details see also 7.2.6.2.
18	1	*Shore Synchronizing Is Active*
		The signal is set while the synchronization of the shore is active.
18	2	*Shore Cable Is Powered*
		In case that synchronize mode A2 or A1 was chosen the signal *Shore Cable Is Powered* is set after the cable test was performed successfully or waived and the circuit breaker CB S1 is closed. Voltage and frequency are ramped up to nominal values. The signal is reset with the end of the start up procedure. For details see also 7.2.6.3 and 7.2.6.4.
18	3	*Shore Ready For Adjustment*
		The signal is set in case synchronize mode A2 was chosen and shore is ready to ramp up and down voltage and frequency. The signal is reset with the start of the start up procedure (see 7.2.6.3) or with end of the running mode. The signal is available in shore mode running, if shore can provide this feature.
18	5	*Shore Synchronized And CB S1 Closed*
		Only in case that synchronize mode A3 was chosen this signal is set when CB S1 on shore is closed. The signal shall be set for a minimum of 5 s.

5.8.3   Stop power status and diagnostic

The following data block includes signals for the Procedure Stop (see Clause 8 and Table 17).

Table 17 – Shore stop power status and diagnostic

Register	Bit	Description
18	8	*Shore Power Will Stop*
		The signal is set as feedback signal for ship command *Ship Co Stop Shore Power* (see 6.7). The signal is reset with the end of the stop procedure. For details see also Clause 8.

5.9   Start up information

This data block, Table 18, includes the characteristic values from shore, which are required for the start up procedure (see 7.2.3).

Table 18 – Shore start up information

Register	Bit	Description
20	*n*	*Shore Rated Short Circuit Current Capacity* Information from the shore which short circuit current will be provided. Data format is unsigned integer interpret with one position after decimal point, unit is kA.
21	*n*	*Shore Max. Rated Power Possible* Information from the shore which power will be provided. Data format is unsigned integer interpret with one position after decimal point, unit is MVA. Requested power from ship shall be less or equal to this power.
22	*n*	*Shore Peak Power Limit* Information from the shore where the peak power limit is set (peak demand level). Data format is unsigned integer interpret with one position after decimal point, unit is MVA.
23	0	*Shore Voltage 400 V Possible*
23	1	*Shore Voltage 440 V Possible*
23	2	*Shore Voltage 690 V Possible*
23	3	*Shore Voltage 6,6 kV Possible*
23	4	*Shore Voltage 11 kV Possible*
23	5	*Spare reserved for application of non standard voltage 6 kV*
23	6	*Spare reserved for application of non standard voltage 10 kV*
23	7-15	*Spares reserved for application of other non standard voltages*
24	0	*Shore Frequency 50 Hz Possible*
24	1	*Shore Frequency 60 Hz Possible*
24	8	*Shore Synchronization Mode A1 possible* Ship side may synchronize.
24	9	*Shore Synchronization Mode A2 possible* Ship may synchronize by sending control signals up and down for voltage / frequency to shore.
24	10	*Shore Synchronization Mode A3 possible* Shore may synchronize.
NOTE e.g. for short circuit current and rated power: 100 = 10,0 kA and 10 = 1,0 MVA.		

5.10 Droop values

This data block includes information from a static frequency converter about adapted frequency and voltage droop, see Table 19. For details see 7.2.2.

Table 19 – Shore droop values

Register	Bit	Description
26	*n*	*Shore Frequency Droop* Information for ship where frequency is adjusted in the static frequency converter. Data format is unsigned integer interpret with one position after decimal point, unit is %. For further details see also Clause 7.
27	*n*	*Shore Voltage Droop* Information for ship where voltage is adjusted in the static frequency converter. Data format is unsigned integer interpret with one position after decimal point, unit is %. For further details see also Clause 7.
NOTE e.g. for droop: 100 = 10,0 % droop, 50 = 5,0 % droop.		

5.11 Energy meter values

The ship may log the power consumption with the energy meter values, see Table 20. The start value is logged at closing of CB S1 and the stop value is logged at opening of CB S1. In the case the power delivery from shore was interrupted (repeated opening and closing of CB S1) the ship side shall consider the sum of the different start and stop values.

Table 20 – Shore energy meter values

Register	Bit	Description
28	n	*Energy Meter Start Value*
: : : 29	n	For ships logging of the power consumption. Data format is double unsigned integer, unit is kWh. For data format details see 9.2. By closing of the circuit breaker CB S1 the actual energy meter value is logged in the energy meter start value.
30	n	*Energy Meter Stop Value*
: : : 31	n	For ships logging of the power consumption. Data format is double unsigned integer, unit is kWh. For data format details see 9.2. By opening of the circuit breaker CB S1 the actual energy meter value is logged in the energy meter stop value.

5.12 Start up data

The shore start up data is available for logging and identifying the harbor, see Table 21.

Table 21 – Shore start up data

Register	Bit	Description
32	n	*Shore Identification*
: 63	n	For ships logging. Data format is string with a maximum text length of 64 characters. For data format details see 9.3.

6 Interface ship

6.1 Version number

The compatibility of the ship side may be checked on the basis of the version number high register, see Table 22.

Table 22 – Checking of compatibility of the ship side

Register	Bit	Description
0	0-7	*Ship Version Number LB* *Ship Version Number LB* identifies the interface version related to this standard (edition number of the standard) with data quantity and addresses of the data packet for which the running software was designed.
0	8-15	*Ship Version Number HB* *Ship Version Number HB* identifies the version of the manufacturer-specific ship side software.
NOTE e.g. for edition number of the standard: 10 = 80005-2 ed. 1 and 20 = 80005-2 ed. 2 and 30 = 80005-2 ed. 3.		

6.2 Ship communication fault detection register

The communication validity may be checked by the periodically change of the value of this register, additionally of existing diagnostic of communication functions, see Table 23.

Table 23 – Detection of communication fault

Register	Bit	Description
1	*n*	*Ship communication fault detection register* The value of *Ship communication fault detection register* is incremented every second.

6.3 Operation modes

6.3.1 Basic operation modes

The basic operation modes indicate in which procedure and state the ship side is actually working, see Table 24. Only one mode out of the basic modes may be active at the same time.

Table 24 – Ship basic operation modes

Register	Bit	Description
2	0	*Ship Mode Start Up* Ship system is in start up procedure. Ship may start shore side. For details see Clause 7.
2	1	*Ship Mode Running* Ship has closed all circuit breakers and opened all earthing switches. System is powered from shore side.
2	2	*Ship Mode Stop* Ship is in Stop procedure. For details see Clause 8. At the end of *Ship Mode Stop* system changes to *Ship Mode Standby*. To prevent black-out at least one onboard generator should be running and synchronized to the ships grid prior to go to *Ship Mode Stop*.
2	3	*Ship Mode Emergency Stop* Ship is in emergency stop. The following actions are automatically executed • The pilot loop is opened immediately. • The circuit breakers S2 and S3 are opened immediately After opening of the circuit breaker S2 the earthing switch SE2 may be closed, see 4.9 of IEC/ISO/IEEE 80005-1: 2012. A reset of the system is required. The *Ship Mode Emergency Stop* is set if one of the following conditions is fulfilled: • Emergency stop button onshore is pressed • One alarm on shore is set • Emergency stop button onboard is pressed • One alarm on ship is set • Communication fault detection register error is detected and bypass key on ship is not in "on" position and Ship is not in *Ship Mode Running.* Pilot loop is opened immediately and ship is in *Ship Mode Emergency Stop*. The *Ship Mode Emergency Stop* is reset after the activating condition is eliminated, CB S2 and S3 are open, SE2 is closed and the system is acknowledged. After this acknowledgement the system changes to *Ship Mode Standby*.
2	4	*Ship Mode Standby* Ship is in standby, only system warnings and alarms are monitored. If no warning is active and the switches are in initial position (CB S2 and S3 open, SE2 closed) the system is ready for start up.

6.3.2 Optional operation mode cable test

The operation mode cable test indicates that the ship system is in the procedure to perform a cable test, see Table 25. The shore will power the cable with nominal voltage but reduced power. The ship system is waiting for the result of the test from the shore side.

Table 25 – Ship optional operation mode cable test

Register	Bit	Description
2	8	*Ship Mode Cable Test* The *Ship Mode Cable Test* is set (see 7.2.5) after receiving of the command *Shore Co Switch To Test Position* from shore. The signal is reset with the signal *Shore Cable Test End* from shore.

6.3.3 Operation modes synchronization

The synchronization operation mode indicates for which type of synchronization the ship side is prepared according to its choice (see 7.2.3 and 7.2.6), see Table 26. Only one mode out of the synchronization modes may be active at the same time.

Table 26 – Ship operation modes synchronization

Register	Bit	Description
3	0	*Ship Mode Synchronization A1* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the ship side synchronizes to the shore side and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.2).
3	1	*Ship Mode Synchronization A2* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the shore side synchronizes to the ship side and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.3).
3	2	*Ship Mode Synchronization A3* The operation mode is set with the choice of the synchronize mode (see 7.2.3): the shore side synchronizes to the ship side and resets at the end of the start up procedure. For details see Clause 7 (see 7.2.6.4).

6.4 Alarms

The alarms indicate a critical condition onboard, which trips the ship system, see Table 27. The alarm is set if a basic subsystem (protection relay) gives an alarm signal. Alarms disappear as soon as the alarm is gone and, if required, additionally acknowledgement on the subsystem. Additional alarms may be indicated in the "System Summary Alarm" (see 6.8.1), but these alarms are not specified in detail within this data block. The shore side will trip after receiving of an alarm (via pilot loop and this interface).

Table 27 – Ship alarms

Register	Bit	Description
5	5	*Ship Alarm Circuit Breaker Protection*

6.5 Warning

The warnings indicate a critical condition onboard, which will not trip the shore system, see Table 28. If a warning is active in standby mode it is not possible to initialize the start up procedure. For the time being there are no warnings defined in the standard. Additional warnings may be indicated in the *Ship Summary Warning* (see 6.8.1), but these warnings are not specified in detail within this data block.

Table 28 – Ship warnings

Register	Bit	Description
7	0-15	Reserved for additional ship warnings

6.6 Status of switches

The information block status of switches shows the state of all involved circuit breakers, earthing and auxiliary switches, see Table 29. If not open and not closed, then switch is considered in intermediate position (for example CB S2 and S3, SE2).

Table 29 – Ship status of switches

Register	Bit	Description
9	0	*CB S2 Open*
9	1	*CB S2 Closed*
9	2	*Earth Switch SE2 Open*
9	3	*Earth Switch SE2 Closed*
9	4	*CB S3 Open*
9	5	*CB S3 Closed*
9	8	*Ship Emergency Stop Button* The signal indicates that at least one emergency stop button is pressed. As long as the emergency stop button is not released the system cannot be acknowledged.

6.7 Commands

Ship commands are used to send requests to the shore side (see Clause 7 and Table 30). A signal change 0→1 is required for every command at the specified step. The command signal shall be set till the feedback signal is received.

Table 30 – Ship commands

Register	Bit	Description
10	0	*Ship Co Switch To Start Up Mode* Ship indicates the shore side to begin with the start up procedure (*Shore Mode Start Up*). Preconditions for this command are that shore is in *Shore Mode Standby* and ship is in *Ship Mode Standby*, no warnings on shore side and ship side and status of switches in basic position (CB S1, CB S2 and CB S3 open, SE1 and SE2 closed). Feedback signal from shore is *Shore Mode Start up* (see 5.3.1)
10	1	*Ship Co Stop Shore Power* Ship indicates the shore side to begin the stop procedure (*Shore Mode Stop*). Feedback signal from shore is *Shore Power will Stop* (see 5.8.3). Shore is operating in *Shore Mode Stop* (see 5.3.1)
10	2	*Ship Co Start Shore Power* Ship indicates the shore side to take necessary switching actions to be able to power up the ship from shore. Shore opens the earthing switch SE1 after receiving of this start command from ship. Ship opens the earthing switch SE2 after receiving of the feedback signal (see 7.2.4). Precondition is that shore indicates *Shore Power Choice possible* and *Shore Ready for Start*. Feedback signal from shore is *Shore Power is starting* (see 5.8.2.4)
10	3	*Ship Co Test Cable* Ship indicates the shore side that a cable test is requested from ship. Precondition for the command is that shore indicates *Shore Cable Test Ready* (see 5.8.2.4) Feedback signal from shore is *Shore Mode Cable Test* (see 5.3.2)
10	4	*Ship Co No Cable Test* Ship indicates the shore side that a cable test is not requested from ship. Precondition for the command is that shore indicates *Shore Cable Test Ready* (see 5.8.2.5) Feedback signal from shore is *Shore Cable Test End* (see 5.8.2.5)
10	5	*Ship Co Synchronize A1* Ship indicates shore side that it wants to synchronize itself. Feedback signals are *Shore Mode Synchronization A1* (see 5.3.3) and *Shore Synchronizing Mode Possible* (see 5.8.2.3).
10	6	*Ship Co Synchronize A2* Ship indicates shore side that it wants to synchronize itself with the aid of the converter onshore. Feedback signals are *Shore Mode Synchronization A2* (see 5.3.3) and *Shore Synchronizing Mode Possible* or *Shore Synchronizing Mode Not Possible* (see 5.8.2.3).
10	7	*Ship Co Synchronize A3* Ship indicates shore side that it wants to be synchronized from shore. Feedback signals are *Shore Mode Synchronization A3* (see 5.3.3) and *Shore Synchronizing Mode Possible* or *Shore Synchronizing Mode Not Possible* (see 5.8.2.3).
10	8	*Ship Co Voltage Adjustment Up* This command is only active if *Ship Mode Synchronization A2* is active and signal *Shore Ready For Adjustment* is sent from shore (see 7.2.6.3) or in *Shore Mode Running*. Ship indicates shore side that the voltage shall be increased. As long as the signal is received the shore will ramp up the voltage. In case of a communication error the ramp up of the voltage will stop. Feedback: No signal
10	9	*Ship Co Voltage Adjustment Down* This command is only active if *Ship Mode Synchronization A2* is active and signal *Shore Ready For Adjustment* is sent from shore (see 7.2.6.3) or in *Shore Mode Running*. Ship indicates shore side that the voltage shall be decreased. As long as the signal is received the shore will ramp down the voltage. In case of a communication error the ramp down of the voltage will stop. Feedback: No signal

Register	Bit	Description
10	10	*Ship Co Frequency Adjustment Up* This command is only active if *Ship Mode Synchronization A2* is active and signal *Shore Ready For Adjustment* is sent from shore (see 7.2.6.3) or in *Shore Mode Running*. Ship indicates shore side that the frequency shall be increased. As long as the signal is received the shore will ramp up the frequency. In case of a communication error the ramp up of the frequency will stop. Feedback: No signal
10	11	*Ship Co Frequency Adjustment Down* This command is only active if *Ship Mode Synchronization A2* is active and signal *Shore Ready For Adjustment* is sent from shore (see 7.2.6.3) or in *Shore Mode Running*. Ship indicates shore side that the frequency shall be decreased. As long as the signal is received the shore will ramp down the frequency. In case of a communication error the ramp down of the frequency will stop. Feedback: No signal

6.8   Status and diagnostic

6.8.1   General status and diagnostic

Ship general status and diagnostic data block includes summary signals and overall signals for the complete system, see Table 31.

Table 31 – Ship general status and diagnostic

Register	Bit	Description
12	0	*Ship No Fault* If the system is free of every alarm and warning the signal is set. With appearance of an alarm or warning the signal is reset.
12	1	*Ship Fault* *Ship Fault* is the inverted signal of *Ship No Fault* for safety reasons. *Ship Fault* is the summary signal for *Ship Summary Alarm* and *Ship Summary Warning* from ship side.
12	2	*Ship Summary Alarm* The signal is a summary signal for all alarms (see 6.4) and in addition for further additional system alarms, which are not listed in the alarm data block. The *System Summary Alarm* is reset as soon as the system is free of every alarm. Ship and shore side will automatically perform an emergency stop.
12	3	*Ship No Summary Alarm* *Ship No Summary Alarm* is the inverted signal of *Ship Summary Alarm* for safety reasons.
12	4	*Ship Summary Warning* The signal is a summary signal for all warnings (see 6.5) and in addition for further additional system warnings, which are not listed in the warning data block. The *Ship Summary Warning* is reset as soon as the system is free of every warning.
12	6	*Ship Different Interface Version* This signal is set, if ship identifies different version numbers (*Shore Version Number LB* and *Ship Version Number LB*) for the interface version between shore and ship (see 5.1 and 6.1).
12	7	*Ship Interface Version Is Compatible* This signal is set, if the installed software on ship is able to handle the detected interface Version (*Shore Version Number LB*) of the shore. The signal is only set if a different interface version between ship and shore is detected and shore has a lower version number than ship side.

6.8.2   Start up status and diagnostic

6.8.2.1   General

This following data blocks include indications in which work step the ship is actually active (see 7.2).

6.8.2.2   Status and diagnostic / droop values

The following data block includes signals for the subprocedure choice droop values (see 7.2.2 and Table 32).

Table 32 – Ship status and diagnostic/ droop values

Register	Bit	Description
14	1	*Ship Droop Values Required* Ship indicates shore that droop adaptation is required.
14	2	*Ship Droop Values Valid* The signal is set as soon as the droop values in the data block are valid (see 6.10 and 7.2.2). The signal shall be reset with the reply from shore *Shore Droop Values Valid*.
14	3	*Ship Droop Values Skip* By setting this signal shore will skip the subprocedure for choice droop values (see 7.2.2). The signal is reset with the end of the start up procedure.
14	4	*Ship Droop Values Not Accepted* Ship indicates shore that the received droop values are not accepted and accordingly ship will send new droop values, after which shore will also send new values. The signal shall be reset by sending the new values *Ship Droop Values Valid* or by skipping of the droop values *Ship Droop Values Skip*.
14	5	*Ship Droop Values Accepted* Ship indicates shore that the sent droop values are accepted. Ship and shore will end the subprocedure for droop values. The signal is reset with the end of the start up procedure.

6.8.2.3   Status and diagnostic / start of power

The following data block includes signals for the subprocedure Start of Power (see 7.2.4 and Table 33).

Table 33 – Ship status and diagnostic/ start of power

Register	Bit	Description
16	0	*Ship Ready For Start* Ship sets the signal after the choice of the power and synchronize mode (see 7.2.3) is done and shore indicates *Shore Ready For Start*. The signal is reset with the end of the start up mode.
16	2	*Ship Permission To Close Shore CB* The signal is set after shore indicates *Shore Power Is Starting* (see 5.8.2), as permission to proceed with the start up procedure and allow switching operation of shore CB. Signal is reset after receiving the signal *Shore Ready For Cable Test*. The *Ship Permission To Close Shore CB* is logged onshore and valid for the rest of the start up procedure.

6.8.2.4   Optional status and diagnostic / cable test

The following data block includes signals for the shore indicating which work step is actually active within the cable test procedure (see 7.2.5 and Table 34).

Table 34 – Optional ship status and diagnostic/ cable test

Register	Bit	Description
17	6	*Ship Switched To Cable Test Position* The signal is the feedback signal for the command *Shore Co Switch To Cable Test Position* (see 5.7). This signal is active when CB S2 is in isolated position and SE2 is open.

6.8.2.5   Status and diagnostic / synchronization

This data block includes signals for the subprocedure Synchronization (see 7.2.6 and Table 35).

Table 35 – Ship status and diagnostic/ synchronization

Register	Bit	Description
18	4	*Ship Ready To Close CB S3* At the end of the cable test procedure with receiving the signal *Shore Cable Test End* ship indicates shore that CB S3 may be closed, if the synchronize mode A3 was chosen. The signal is reset with the end of the start up procedure.
18	5	*Ship Synchronized And CB S3 Closed* The signal is set, if ship is performing the synchronizing (*Ship Mode Synchronization A2* or *Ship Mode Synchronization A1*) and CB S3 on ship is closed. The signal shall be set for a minimum of 5 s.

6.8.3   Stop power status and diagnostic

The following data block includes signals for the Procedure Stop (see Clause 8 and Table 36).

Table 36 – Ship stop power status and diagnostic

Register	Bit	Description
18	9	*Ship Shore Power Zero* The signal is set in the stop procedure, when ship's own power system has taken over the complete load and no power from shore is required any more (see Clause 8). The signal is reset at the end of the stop procedure (shore in *Shore Mode Standby*).

6.8.4   Additional status and diagnostic

These special signals are required to identify the fault mode (see 5.3.4 and Table 37).

Table 37 – Ship additional status and diagnostic

Register	Bit	Description
18	10	*Ship Generators All Off* The signal is set when all generators on ship are off or not connected to the busbar.
18	11	*Ship Generators Min One On* The signal is set when at least one generator on ship is on and connected to the busbar.

6.9   Start up information

This data block includes the characteristic values from ship, which are required for the start up procedure (see 7.2.3 and Table 38).

Table 38 – Ship start up information

Register	Bit	Description
20	*n*	*Ship Rated Short Circuit Current* Data format is unsigned integer interpret with one position after decimal point, unit is kA.
21	*n*	*Ship Power Requested* Information from the ship which power will be required. Data format is unsigned integer interpret with one position after decimal point, unit is MVA. Provided power from shore shall be higher or equal to this power.
23	0	*Ship Voltage 400 V Requested*
23	1	*Ship Voltage 440 V Requested*
23	2	*Ship Voltage 690 V Requested*
23	3	*Ship Voltage 6,6 kV Requested*
23	4	*Ship Voltage 11 kV Requested*
23	5	*Spare reserved for application of non standard voltage 6 kV*
23	6	*Spare reserved for application of non standard voltage 10 kV*
23	7-14	*Spares reserved for application of other non standard voltages*
23	15	*Shore Connection Transformer onboard is used*
24	0	*Ship Frequency 50 Hz Requested*
24	1	*Ship Frequency 60 Hz Requested*
NOTE e.g. for short circuit current and rated power: 100 = 10,0 kA and 10 = 1,0 MVA.		

6.10 Droop values

This data block includes information for a static frequency converter to adapt frequency and voltage droop, see Table 39. For details see 7.2.2.

Table 39 – Ship droop values

Register	Bit	Description
26	*n*	*Ships Frequency Droop* Information for shore static frequency converter to adapt frequency droop for easier synchronization. Data format is unsigned integer interpret with one position after decimal point, unit is %. For further details see also Clause 7.
27	*n*	*Ships Voltage Droop* Information for shore static frequency converter to adapt voltage droop for easier synchronization. Data format is unsigned integer interpret with one position after decimal point, unit is %. For further details see also Clause 7.
NOTE e.g. for droop: 100 = 10,0 % droop, 50 = 5,0 % droop.		

6.11 Start up data

The ship start up data are available for logging and identifying the ship, see Table 40. IMO Code, desired energy supplier and ship name shall be available before the command *Ship Co Switch To Start Up Mode* is send to shore side. With a signal change from 0→1 of the command *Ship Co Switch To Start Up Mode* these data are logged on shore side.

Table 40 – Ship start up data

Register	Bit	Description
32	n	*Ship Name*
: 63	n	For harbor logging. Data format is string with a maximum text length of 64 characters. For data format details see 9.3.
64	n	*Ship Identification*
: 73	n	IMO Code for harbor logging. Data format is string with a maximum text length of 20 characters. For data format details see 9.3.
74	n	*Ship Desired Energy Supplier*
: 105	n	For harbor logging. Data format is string with a maximum text length of 64 characters. For data format details see 9.3.

7 Start up procedure

7.1 General

The start up procedure is the procedure to initialize the power connection to the ship. General, technical and safety information are exchanged during this procedure. The procedure shall be executed sequentially and shall be stopped and restarted if the transfer time limit is exceeded or a safety shut-down is activated, see IEC/ISO/IEEE 80005-1:2012, 9.2 and 9.3.

7.2 Data flow

7.2.1 Initialize start up

The following conditions shall be fulfilled to initialize the start up procedure:

- The communication link is connected and is in operation
- Shore side shall be in *Shore Mode Standby*
- Shore system has no active alarms or warnings (*Shore No Fault*)
- Ship side shall be in Mode *Ship Mode Standby*
- Ship system has no active alarms or warnings (*Ship No Fault*)
- Pilot loops are closed
- Circuit breaker S1 is in OPEN position
- Earthing switch SE1 is in CLOSED position
- Circuit breaker S2 is in OPEN position
- Earthing switch SE2 is in CLOSED position
- Circuit breaker S3 is in OPEN position

If the above conditions are fulfilled ship may initialize the start up procedure with the command *Ship Co Switch To Start Up Mode* (see 6.7). A signal change from 0→1 is required for the command. Shore changes to the operation mode *Shore Mode Start Up* as feedback. Before sending the command the ship shall ensure that the Start up data (see 6.11) are filled in correctly. With the change of the operation mode to *Shore Mode Start Up* these data are logged on shore side for this power connection. Ship may abort the Start up procedure with the stop command *Ship Co Stop Shore Power* (see 6.7) and shore will thereupon change the operation mode back to *Shore Mode Standby*.

7.2.2 Choice droop values

If the shore side indicates the *Shore Mode Start Up* the droop value subprocedure is active.

Shore indicates, if the adaptation of droop values is possible or not (*Shore Droop Values Possible*). Ship indicates, if the adaptation of droop values is required (*Ship Droop Values Required*) or not. If the adaptation of the droop values is not required or not possible shore sets the signal *Shore Droop Values Done* and ship and shore end this subprocedure. If the droop adaptation is required and possible ship enters the droop values (see 6.10) and sets the signal *Ship Droop Values Valid* (see 6.8.2.1 and 5.8.2.1) to mark that the values are filled out. Shore reads the values and enters the adapted droop values. The signal *Shore Droop Values Valid* is set by shore too to mark that the values are filled out. Ship side may accept or reject the received droop values by sending the signals *Ship Droop Values Accepted* or *Ship Droop Values Not Accepted*. If the droop values are rejected ship may send new droop values and therefore receive new values from shore. At any time ship may skip the subprocedure by sending the signal *Ship Droop Values Skip*. With sending the signal *Ship Droop Values Accepted* from ship the shore side will log the values and send the signal *Shore Droop Values Done* and with this signal end this subprocedure on ship and on shore. See also 5.8.2.1 and 6.8.2.1.

7.2.3   Choice power and synchronize mode

If the shore side indicates *Shore Droop Values Done* the power choice and synchronize mode subprocedure is active.

Shore indicates *Shore Power Choice Possible* (see 5.8.2.3 and 5.9), if the following conditions are fulfilled:

- Shore rated I_{k3} capacity   ≤   Ship rated I_{k3}
- Shore max. rated power possible   ≥   Ship power requested
- One of the voltage values of the shore   =   Requested voltage value of ship
- One of the frequency values of the shore   =   Requested frequency value of ship

where I_{k3} is steady-state three phase short-circuit current.

If the above conditions are not fulfilled shore sends *Shore Power Choice Not Possible*.

In addition the synchronizing mode shall be selected by the ship. With every signal change from 0→1 of one of the commands S*hip Co Synchronize A 1, Ship Co Synchronize A 2* or *Ship Co Synchronize A 3* shore side is sending the feedback signal *Shore Synchronizing Mode Possible* or *Shore Synchronizing Mode Not Possible*. Furthermore if the synchronizing mode is possible, shore and ship side change their special operation mode (see 5.3.3 and 6.3.3) accordingly.

Power choice and synchronize mode may be changed as long as the ship is not sending the *Ship Co Start Shore Power* command (see 6.7).

The shore side is logging all data (power choice and synchronize mode) with the *Ship Co Start Shore Power* command and the feedback signals *Shore Power Choice Possible* and *Shore Synchronizing Mode Possible* will not be updated anymore.

7.2.4   Start of power

If power choice and synchronize mode are selected correctly shore side indicates *Shore Ready For Start*. Ship side also shall indicate *Ship Ready For Start*. Ship initializes the start power procedure by sending the command *Ship Co Start Shore Power* (signal change from 0→1).

Feedback signal from shore is *Shore Power Is Starting*.

Shore opens the earthing switch SE1. Ship opens the earthing switch SE2.

In the following steps (optional cable test and synchronization) the shore shall power the cable. For this reason the ship shall send the signal *Ship Permission To Close Shore CB* as authorization to do so, after the ship receives the signal *Shore Power Is Starting*. See also 5.8.2.4 and 6.8.2.3.

7.2.5 Optional cable test

7.2.5.1 General

After the start of power procedure is carried out, the earthing switches SE 1 and SE 2 are already opened and the permission to close the onshore CB was sent from the ship, the shore indicates to the ship *Shore Cable Test Ready* (see 5.8.2.5 and 6.8.2.4).

The ship has the possibility to execute a cable test or to skip the cable test.

If the ship wants to execute a cable test, it shall send the command *Ship Co Test Cable*, otherwise it shall send the *Ship Co No Cable Test* command (see 6.7). For both signals a change from 0→1 is required.

The different subprocedures are described in 7.2.5.2 and 7.2.5.3.

Optional cable test is ramping up the shore voltage up to nominal voltage, with reduced power, in order to verify the integrity of the cable and plugs and sockets outlets.

7.2.5.2 Execute cable test

After receiving of the command *Ship Co Test Cable* (change from 0→1) the shore side is sending the feedback signal *Shore Mode Cable Test* (see 5.3.2). As soon as the shore is ready the request *Shore Co Switch To Test Position* (see 5.7, 5.8.2.5 and 6.8.2.4) is sent to the ship. The ship side will switch to *Ship Mode Cable Test* and shall ensure that earthing switch SE2 is open and circuit breaker CB S2 is in open position. The ship indicates this status to shore with the *Ship Switched To Test Position* signal. The shore is starting the cable test. It is possible that the cable test effects the circuit breaker S1 (closing and opening is possible). If the cable test was performed successfully, shore sends the signal *Shore Cable Test Ok*, otherwise *Shore Cable Test Not Ok*. If the test was successful the earthing switch SE1 and SE2 stay in open position, otherwise SE1 and SE2 will be closed. Shore indicates the end of the cable test procedure with the signal *Shore Cable Test End* and the cable test mode (*Shore Mode Cable Test*, *Ship Mode Cable Test*) is reset onshore and onboard. The subprocedure for synchronizing is activated automatically if the cable test was performed successfully, otherwise if the test was not successful the shore will automatically launch the stop procedure.

7.2.5.3 No cable test

After receiving of the command *Ship Co No Cable Test* (change from 0→1) the shore side is sending the feedback signal *Shore Cable Test End*. The subprocedure for synchronizing is activated automatically.

7.2.6 Synchronizing

7.2.6.1 General

According to the selected Synchronizing Mode (see 7.2.3) one of the following alternatives is performed. Precondition for synchronizing is that the cable test was performed successful or waived. See also 5.8.2.6 and 6.8.2.5.

7.2.6.2 Synchronizing alternative 1 (A1)

In this mode the ship side is synchronizing to the shore side. This mode is default mode. Shore is in *Shore Mode Synchronization A1* and ship side is in *Ship Mode Synchronization A1*

(see 5.3.3 and 6.3.3). After the optional cable test was performed successfully or waived the shore has already closed the circuit breaker CB S1. Ship closes circuit breaker S2. Shore ramps up to nominal values (voltage, frequency) and will send the signal *Shore Cable Is Powered* (see 5.8.2.6 and 6.8.2.5). Ship starts the synchronizing. After successful synchronizing the circuit breaker S3 on ship is closed and ship changes the operation mode to *Ship Mode Running*. Also shore side changes the operation mode to *Shore Mode Running*" after receiving the signal *Ship Synchronized And CB S3 Closed*. The start up procedure is finished and all auxiliary flags are reset.

7.2.6.3   Synchronizing alternative 2 (A2)

In this mode the ship side synchronizes the shore by sending commands for voltage and frequency adjustment. This mode may be used, as additional option, when the shore side is equipped to be synchronized to the ship and the switching over from ship to shore is controlled by the ships power automation system. Shore is in *Shore Mode Synchronization A2* and ship side is in *Ship Mode Synchronization A2* (see 5.3.3 and 6.3.3).

After the optional cable test was performed successfully or waived the shore has already closed the circuit breaker CB S1. Ship closes circuit breaker S2. Shore ramps up to nominal values (voltage, frequency) and sends the signal *Shore Cable Is Powered* and *Shore Ready For Adjustment* (see 5.8.2.6, 6.7 and 6.8.2.5). Ship synchronizes shore side by sending step up and down commands (for example *Ship Co Voltage Adjustment Up* or *Ship Co Frequency Adjustment Up*) for frequency and voltage. As soon as shore is synchronous with the ship the circuit breaker S3 on ship side is closed and ship changes the operation mode to *Ship Mode Running*. Also shore side changes the operation mode to *Shore Mode Running* after receiving the signal *Ship Synchronized And CB S3 Closed*. The start up procedure is finished and all auxiliary flags are reset.

7.2.6.4   Synchronizing alternative 3 (A3)

In this mode the shore side is synchronizing to the ship side. This mode may be used, as additional option, when the shore side is equipped to be synchronized to the ship. Shore is in *Shore Mode Synchronization A3* and ship side is in *Ship Mode Synchronization A3* (see 5.3.3 and 6.3.3).

Ship side indicates to shore *Ship Ready To Close CB S3*. If shore is ready *Shore Permission To Close Ship CB* (see 5.8.2.5 and 6.8.2.5) is sent to ship. Ship is closing circuit breaker S2 and then S3. As soon as the feedback signal from ship indicates that circuit breakers S2 and S3 are closed, the shore side starts the synchronizing. After successful synchronizing the circuit breaker S1 on shore side is closed and shore changes the operation mode to *Shore Mode Running*. With the signal *Shore Synchronized And CB S1 Closed* the ship changes the operation mode to *Ship Mode Running*. The start up procedure is finished and all auxiliary flags are reset.

8   Procedure stop

Anytime the ship may initialize a controlled shutdown of the onshore power supply. To initialize the stop procedure the ship shall send the *Ship Co Stop Shore Power* command (see 6.7 and 5.8.3).

For LNG terminals, the shore can initialize a controlled shutdown of the onshore power supply at any time if the ship moves past the warning range of allowable motion forward, aft or outward from the dock (*Shore Warning ESD1*). The emergency shutdown philosophy agreed between terminal and ship may require the ESD-1 signal to be used in the event of other conditions (see Annex E, 8.6 of IEC/ISO/IEEE 80005-1:2012,). If the shore detects the ESD-1 condition or receives *Ship Co Stop Shore Power*, the shore side changes to *Shore Mode Stop* (see 5.3.1). The ship side changes to *Ship Mode Stop*, when the signal *Shore Warning ESD1* is received.

Shore side changes to *Shore Mode Stop* and ship side changes to *Ship Mode Stop* (see 5.3.1 and 6.3.1).

According to IEC/ISO/IEEE 80005-1 ship uses an automatic or manual load adjustment. The ship shall restore power to prevent black-out before the stop procedure may proceed. The ship generator is powered up until it has taken over the whole electrical load with acceptable load step for the ships prime mover and the shore power is reduced. Ship sends signal *Ship Shore Power Zero* to shore, which stops further power supply from shore.

Ship opens CB S3 and S2 and signals the opening of CB S2 to shore.

Shore awaiting the signal that circuit breaker S2 (*CB S2 Open*) is open. After receiving of this signal shore opens circuit breaker S1 and closes earthing switch SE1. With opening of CB S1 the energy stop value is logged in the data packet and may be read out from the ship for data logging. After opening CB S1 onshore, the ship closes the earthing switch SE2. After receiving of the SE1 closed signal and verifying that SE2 is also closed, the ship gives a signal to the operator onboard, that the power cable may be disconnected with both sides earthed.

Shore side changes to *Shore Mode Standby* and ship side changes to *Ship Mode Standby* (see 5.3.1 and 6.3.1), all switches are in initial position.

9 Format of data types (big endian format)

9.1 Format of data type WORD (One register)

The format of data type WORD (for one register) shall be as shown in Figure 3.
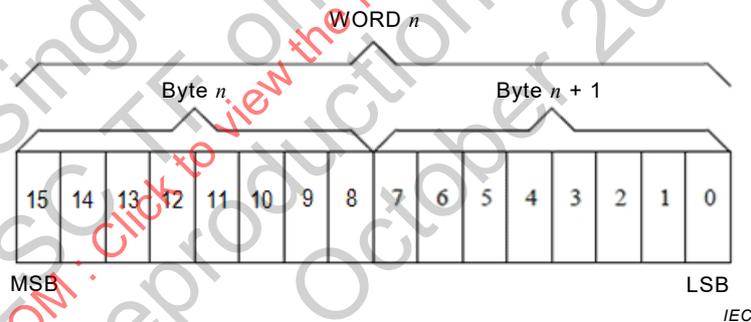
Figure 3 – Format of data type WORD

9.2 Format of data type DWORD (Two registers)

The format of data type DWORD (for two registers) shall be as shown in Figure 4.
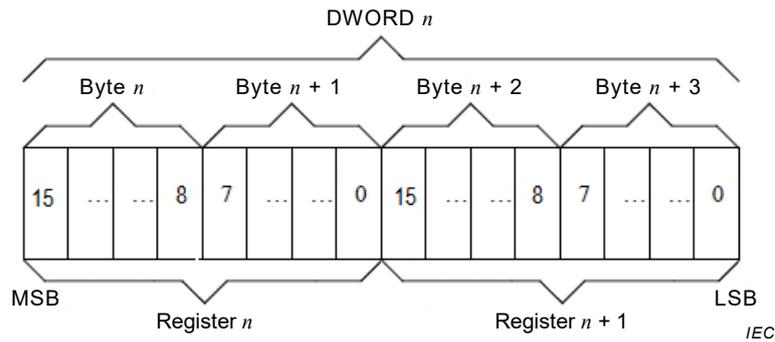
Figure 4 – Format of data type DWORD

9.3 Format of data type STRING (Zero terminated string of single byte ASCII characters)

The format of data type STRING (Zero terminated string of single byte ASCII characters) shall be as shown in Figure 5.
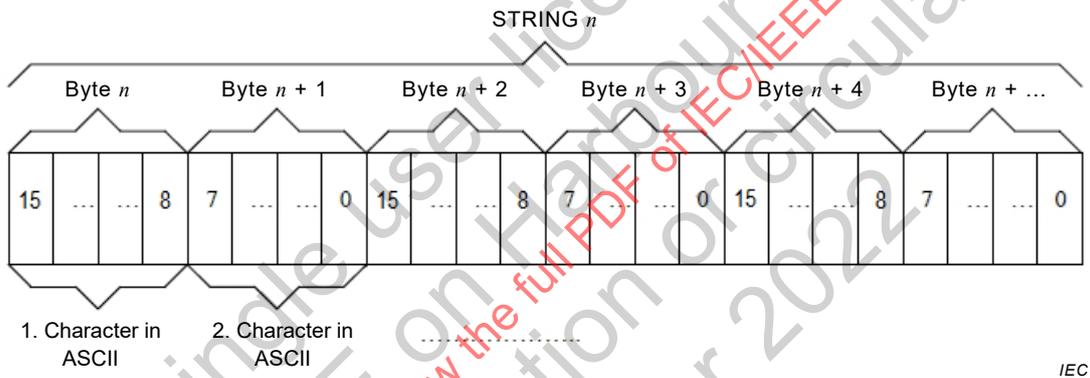
Figure 5 – Format of data type STRING

10 Verification and testing

Verification and tests shall be performed, see IEC/ISO/IEEE 80005-1.

Annex A
(normative)

Cruise ship communication system requirements

A.1 Scope

This annex describes the communication and signal requirements for cruise ship HV shore connection, as required by the Annex C of IEC/ISO/IEEE 80005-1:2012.

A.2 Radio communication

The official communication system for shore power operations is VHF radios. A base station radio will be installed in the engine control room of the ship; handheld radios will be assigned to the staff electro technical officer and the 1st electro technical officer. The shore power operator will also have a base radio station and/or handheld radio. Radio communication shall be established at the first opportunity between ship and shore personnel using previously arranged call signs.

A.3 Safety and control circuits (Figure C.3 of IEC/ISO/IEEE 80005-1:2012)

Safety signals and control circuits which are monitored and annunciated on the ship and shore side substation shall be according to the Table A.1. These signals are connected to the ship through two multi-conductor cables, one with signal voltage of 110 VDC and the other cable at 24 VDC, and shall use connectors type screw terminated with wire protection, type EPIC HBE 24 10196000 (for plug) and EPIC HBE 24 10197000 (for outlet), as shown in Figure A.1.

Table A.1 – Safety signals and control circuits for cruise applications

110 VDC contact xignals		
Permission to close 6,6 kV secondary circuit breaker	1,2	Ship side NormallyOpen (N.O.) contact
Emergency stop	3,4	Ship side Normally Closed (N.C.) switch
6,6 kV circuit breaker position	5,6	Shore side N.O. contact
11 kV circuit breaker position	14,15	Shore side N.O. contact
Permission to close 11 kV secondary circuit breaker	16,17	Ship side N.O. contact
Shore ground indication	7,8	Shore side N.O. contact
Ship frequency selection	9,10	Ship side N.O. contact
Reduce power warning	11,12	Shore side N.O. contact
Shutdown expected warning	11,13	Shore side N.O. contact
24 VDC contact signals	1,2	Ship side N.O. contact
Permission to close 6,6 kV secondary circuit breaker		
Ship cable ground check monitor	3,4	Shore side (4) N.O. series contacts
Capacitor alarm	5,6	Shore side N.O. contact
Capacitor stage 2	7,8	Shore side N.O. contact
Transformer temperature warning	9,10	Shore side N.C. contact
Transformer temperature alarm	11,12	Shore side N.C. contact
Capacitor permission to close	13,18	Ship side N.O. contact
Capacitor stage 1	14,15	Shore side N.O. contact
Permission to close 11 kV secondary circuit breaker	16,17	Ship side N.O. contact
Capacitor circuit breaker position	19,20	Shore side N.O. contact
Capacitor stage 3	21,22	Shore side N.O. contact
Ground monitoring	23,24	Pin 24 solidly earthed at earthing point of power sockets
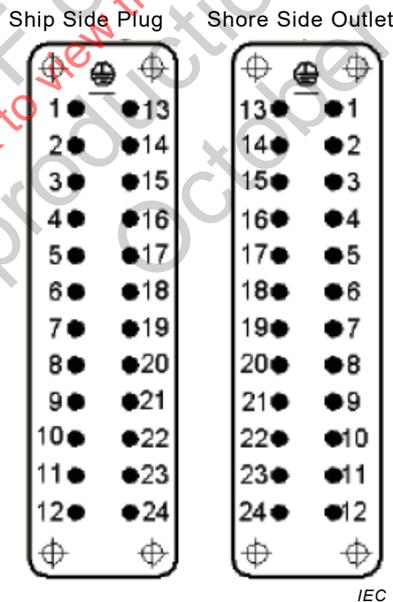
Figure A.1 – Safety and control circuits connectors for cruise ships

A.4   Ship SCADA

A.4.1   General

Various electrical parameters and circuit breaker positions are monitored on the shore side (master PLC, which requests data from ship) to allow archiving of data trends and providing effective time stamping for sequence of event reporting. The communication protocol is Modbus RTU via two wire (half duplex) Serial RS485.

A.4.2   Connector

Pins C and D of the four pin connector are used. Pin C is for the positive (+Tx/Rx) terminal and D is for the negative (-Tx/Rx) terminal. Pins A and B are spare. Figure A.2 shows the SCADA connectors configuration.

Figure A.2 – SCADA straight plug / box mounting receptacle MS 3102E / MS3106E (MIL-DTL-5015)

A.4.3   Modbus RTU

Modbus configuration, data registers, range and scaling for the ship SCADA communications shall be in accordance with Table A.2.

Ship SCADA

Modbus RTU

Data bits	8
Stop bits	1
Parity	Even
Slave address	2

Table A.2 – Modbus configuration

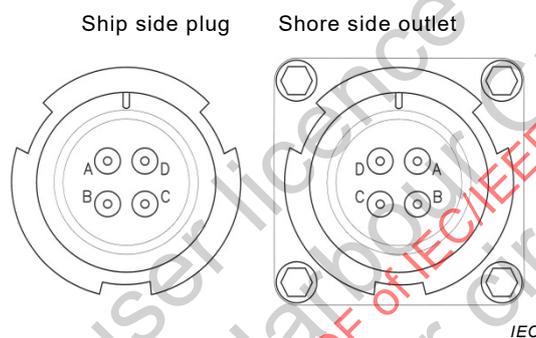| Name	Type	Modbus register	Register size	Register range	Scale factor (multiply)	Actual range (eng. value)	Range in register	Units
Generator 1 CB status	bin	40001	16 bit, bit 0	N/A	N/A	N/A	N/A	N/A
Generator 2 CB status	bin	40001	16 bit, bit 1	N/A	N/A	N/A	N/A	N/A
Generator 3 CB status	bin	40001	16 bit, bit 2	N/A	N/A	N/A	N/A	N/A
Generator 4 CB status	bin	40001	16 bit, bit 3	N/A	N/A	N/A	N/A	N/A
Gas turbine CB status	bin	40001	16 bit, bit 10	N/A	N/A	N/A	N/A	N/A
Bus frequency	analog	40100	signed 12 bit	0 to 2 047	multiply by 100 subtract 5 000	50,00 – 70,00	0 – 2 000	Hz
Gen 1 A-B Voltage	analog	40101	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
Gen 1 B-C Voltage	analog	40102	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
Gen 1 C-A Voltage	analog	40103	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
Gen 1 A phase Amps	analog	40104	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 1 B phase Amps	analog	40105	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 1 C phase Amps	analog	40106	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 1 kW	analog	40107	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MW
Gen 1 kVAR	analog	40108	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16 00	-1 600 – 1 600	MVAR
Gen 2 A-B Voltage	analog	40109	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 2 B-C Voltage	analog	40110	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 2 C-A Voltage	analog	40111	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 2 A phase Amps	analog	40112	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 2 B phase Amps	analog	40113	signed 12 bit	0 to 2 047	1,0	0 – 400	0 – 1 400	A
Gen 2 C phase Amps	analog	40114	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 2 kW	analog	40115	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MW
Gen 2 kVAR	analog	40116	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MVAR
Gen 3 A-B Voltage	analog	40117	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 3 B-C Voltage	analog	40118	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 3 C-A Voltage	analog	40119	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V

Name	Type	Modbus register	Register size	Register range	Scale factor (multiply)	Actual range (eng. value)	Range in register	Units
Gen 3 A phase Amps	analog	40120	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 3 B phase Amps	analog	40121	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 3 C phase Amps	analog	40122	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 3 kW	analog	40123	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MW
Gen 3 kVAR	analog	40124	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MVAR
Gen 4 A-B Voltage	analog	40125	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 4 B-C Voltage	analog	40126	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 4 C-A Voltage	analog	40127	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	V
Gen 4 A phase Amps	analog	40128	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 4 B phase Amps	analog	40129	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 4 C phase Amps	analog	40130	signed 12 bit	0 to 2 047	1,0	0 – 1 400	0 – 1 400	A
Gen 4 kW	analog	40131	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MW
Gen 4 kVAR	analog	40132	signed 12 bit	-2 047 to 2 047	100,0	-16,00 – 16,00	-1 600 – 1 600	MVAR
GTG A-B Voltage	analog	40133	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
GTG B-C Voltage	analog	40134	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
GTG C-A Voltage	analog	40135	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
GTG A phase Amps	analog	40136	signed 12 bit	0 to 2 047	1,0	0 – 2 000	0 – 2 000	A
GTG B phase Amps	analog	40137	signed 12 bit	0 to 2 047	1,0	0 – 2 000	0 – 2 000	A
GTG C phase Amps	analog	40138	signed 12 bit	0 to 2 047	1,0	0 – 2 000	0 – 2 000	A
GTG kW	analog	40139	signed 12 bit	-2 047 to 2 047	80,0	-25,00 – 25,00	-2 000 – 2 000	MW
GTG kVAR	analog	40140	signed 12 bit	-2 047 to 2 047	80,0	-25,00 – 25,00	-2 000 – 2 000	MVAR
Incoming CB status	bin	40001	16 bit, bit 4	N/A	N/A	N/A	N/A	N/A
Sync. CB status	bin	40001	16 bit, bit 5	N/A	N/A	N/A	N/A	N/A
A phase amperage	analog	40200	signed 12 bit	0 to 2 047	1	0 – 1 500	0 – 1 500	A
B phase amperage	analog	40201	signed 12 bit	0 to 2 047	1	0 – 1 500	0 – 1 500	A
C phase amperage	analog	40202	signed 12 bit	0 to 2 047	1	0 – 1 500	0 – 1 500	A
A-B Voltage	analog	40203	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV

Name	Type	Modbus register	Register size	Register range	Scale factor (multiply)	Actual range (eng. value)	Range in register	Units
B-C Voltage	analog	40204	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
C-A Voltage	analog	40205	signed 12 bit	0 to 2 047	100,0	0 – 13,00	0 – 1 300	kV
kW	analog	40206	signed 12 bit	-2 047 to 2 047	100,0	-17,00 – 17,00	-1 700 – 1 700	MW
kVAR	analog	40207	signed 12 bit	-2 047 to 2 047	100,0	-17,00 – 17,00	-1 700 – 1 700	MVAR
Frequency	analog	40208	signed 12 bit	0 to 2 047	multiply by 100 subtract 5 000	50,00 – 70,00	0 – 2 000	Hz

Annex B
(normative)

Modbus register list

B.1   Scope

This annex describes the Modbus register list for communication between shore and ship.

Modbus register list for shore side shall be in accordance to Table B.1.

Modbus register list for ship side shall be in accordance to Table B.2.

B.2   Shore interface

Table B.1 – Modbus register list for shore side

Register address	Bit(s)	Description	Data type
0	15-0	*Shore Software Version Number HB. Shore Version Number LB.*	WORD
1	15-0	*Shore communication fault detection register*	WORD
2	0	*Shore Mode Start Up*	BOOL
	1	*Shore Mode Running*	BOOL
	2	*Shore Mode Stop*	BOOL
	3	*Shore Mode Emergency Stop*	BOOL
	4	*Shore Mode Standby*	BOOL
	5	*Spare*	BOOL
	6	*Spare*	BOOL
	7	*Spare*	BOOL
	8	*Shore Mode Optional Cable Test*	BOOL
	9	*Spare*	BOOL
	10	*Spare*	BOOL
	11	*Spare*	BOOL
	12	*Spare*	BOOL
	13	*Spare*	BOOL
	14	*Spare*	BOOL
	15	*Spare*	BOOL
3	0	*Shore Mode Synchronization A1*	BOOL
	1	*Shore Mode Synchronization A2*	BOOL
	2	*Shore Mode Synchronization A3*	BOOL
	3	*Spare*	BOOL
	4	*Spare*	BOOL
	5	*Spare*	BOOL
	6	*Spare*	BOOL
	7	*Spare*	BOOL
	8	*Shore Mode Clear Fault*	BOOL
	9	*Shore Mode No Clear Fault*	BOOL
	10	*Spare*	BOOL
	11	*Spare*	BOOL
	12	*Spare*	BOOL
	13	*Spare*	BOOL
	14	*Spare*	BOOL
	15	*Spare*	BOOL
4	15-0	*Spare*	

Register address	Bit(s)	Description	Data type
5	0	Shore Alarm Converter High Temperature	BOOL
	1	Shore Alarm Converter Leakage	BOOL
	2	Shore Alarm Converter Liquid Conductivity	BOOL
	3	Shore Alarm Transformer High Temperature	BOOL
	4	Shore Alarm Transformer Leakage	BOOL
	5	Shore Alarm Circuit Breaker Protection	BOOL
	6	Shore Alarm Cable Length	BOOL
	7	Shore Alarm Cable Mechanical Tension	BOOL
	8	Shore Alarm ESD2	BOOL
	9	Spare	BOOL
	10	Spare	BOOL
	11	Spare	BOOL
	12	Spare	BOOL
	13	Spare	BOOL
	14	Spare	BOOL
	15	Spare	BOOL
6	0	Shore Alarm shore circuit-breaker protection overcurrent	BOOL
	1	Shore Alarm shore circuit-breaker protection overvoltage	BOOL
	2	Shore Alarm shore circuit-breaker protection undervoltage	BOOL
	3	Shore Alarm shore circuit-breaker protection reverse power	BOOL
	4	Shore Alarm Neutral Earthing Resistor Integrity	BOOL
	5	Shore Alarm shore circuit-breaker protection connectors	BOOL
	6	Spare	BOOL
	7	Spare	BOOL
7	0	Shore Warning Protection System Battery Charging Failure	BOOL
	1	Shore Warning Converter High Temperature	BOOL
	2	Shore Warning Converter Liquid Conductivity	BOOL
	3	Shore Warning Transformer High Temperature	BOOL
	4	Shore Warning Cable Length	BOOL
	5	Shore Warning Cable Mechanical Tension	BOOL
	6	Shore Warning ESD1	BOOL
	7	Spare	BOOL
	8	Spare	BOOL
	9	Spare	BOOL
	10	Spare	BOOL
	11	Spare	BOOL
	12	Spare	BOOL
	13	Spare	BOOL
	14	Spare	BOOL
	15	Spare	BOOL
8	15-0	Spare	