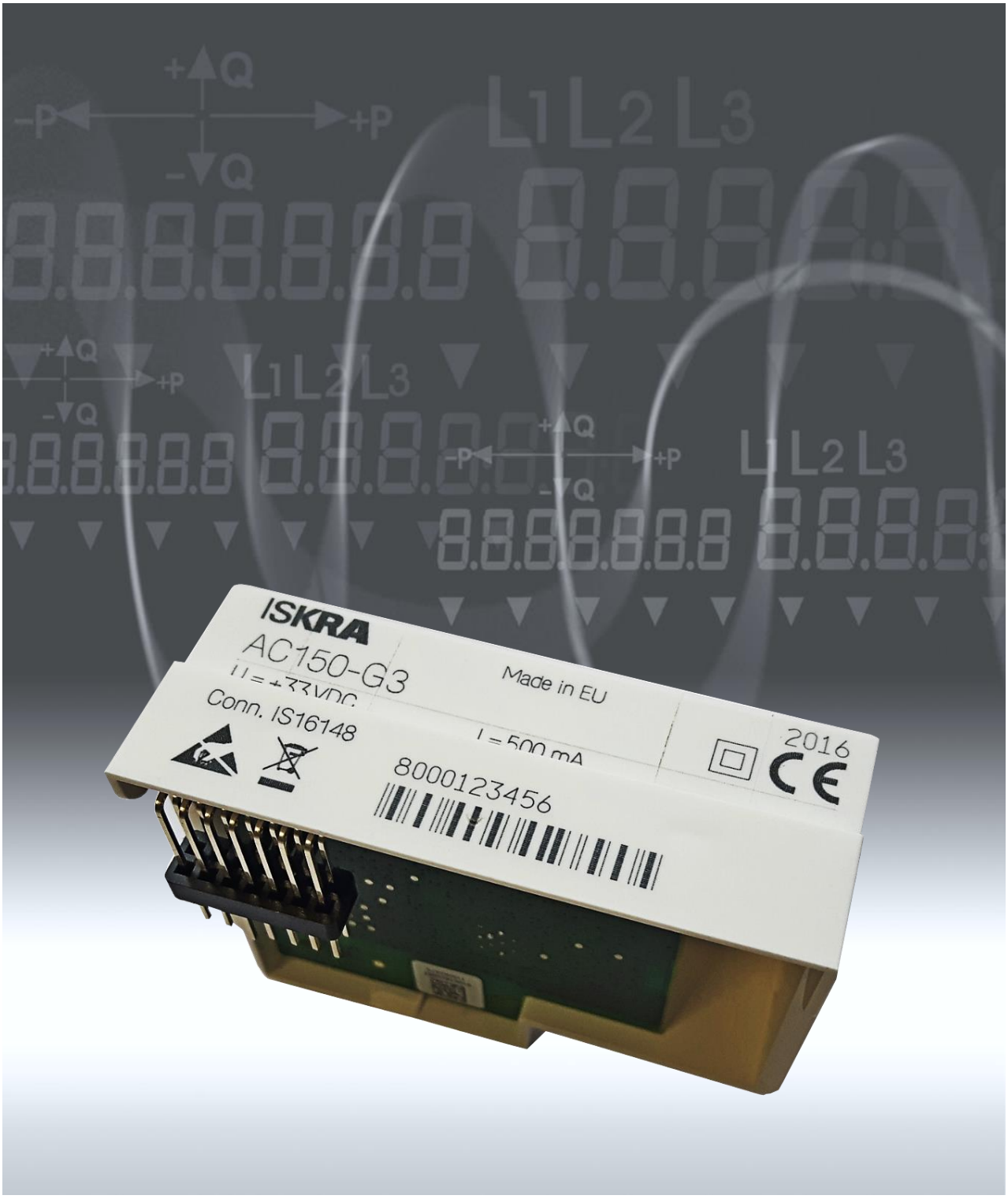
ISKRAEMECO

AC150-G3 – G3-PLC COMMUNICATION MODULE

Technical description



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i. About the Technical description

- This Technical description contains detailed information about the AC150-G3 – G3-PLC communication module, its key features, and functionalities.
- It is intended for a technical audience, who are responsible for the product and its integration into the system.

This technical description should be read in conjunction with the host device documentation.

ii. Definitions, Acronyms and Abbreviations

Abbreviation	Explanation
6LoWPAN	IPv6 Low power Wireless Personal Area Networks
ACK	Acknowledgement
AES	Advanced Encryption Standard
ARQ	Automatic Repeat reQuest
CENELEC	European Committee for Electrotechnical Standardization
CID	Connection ID
CRC	Cyclic Redundancy Check
CSMA-CA	Carrier Sense Multiple Access with Collision Avoidance
DC	Direct Current
DBPSK	Differential Binary Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
D8PS	Eight ary Differential Phase Shift
EAP-PSK	Extensible Authentication Protocol Pre-Shared Key
EN	European Norm
GMK	Grand Master Key
IEEE	Institute of Electrical and Electronics Engineers
IP	Ingress Protection
ITU-T	International Telegraph Union Telecommunication standardization sector
LBD	Long Block Data
LQI	Link Quality Indicator
MAC	Media Access Control address
MSDU	MAC Service Data Unit
PAN	Personal Area Network
PCB	Printed Circuit Board
PLC	Power Line Carrier
PSK	Pre-Shared Key
SNR	Signal to Noise Ratio

iii. Reference documents

- Iskraemeco’s general terms and condition

iv. Versioning

Date	Version	Update
14.02.2017	1.00	Initial version of the document.
04.04.2017	1.01	In the *first CAUTION* of the chapter *1.2.2. Meter/module installation procedure*, the text "…not be higher than nominal meter current." was changed in the "…not be higher than meter maximum current (I_{max})."

TABLE OF CONTENTS

INDEX OF FIGURES

INDEX OF TABLES

1. SAFETY INFORMATION

Safety information used in this Technical description is described with the following symbols and pictograms:

DANGER: for a possibly dangerous situation, which could result in severe physical injury or fatality – attention to a high risk hazards.

WARNING: attention to a medium risk hazards.

CAUTION: for a possibly dangerous situation, which could result in minor physical injury or material damage - attention to a low risk hazards.

Operating instruction: for general details and other useful information.

All safety information in this Technical description describes the type and source of danger; it is possible consequences and measures to avoid the danger.

All safety information written in this document applies to the module.

1.1. Responsibilities

The owner of the meter/module is responsible to assure that all authorized persons who work with the meter read and understand the parts of this Technical description, and Installation and maintenance manual that explains the safe handling with the meter.

The personnel must be sufficiently qualified for the work that will be performed. The installation personnel must possess the required electrical knowledge and skills, and must be authorised by the utility to perform the installation procedure.

The personnel must strictly follow the safety regulations and operating instructions, written in the individual chapters in this document, and the Installation and maintenance manual.

The owner of the meter/module responds specially for the protection of the persons, for prevention of material damage and for training of personnel.

1.2. Safety instructions

1.2.1. Handling and mounting

At the beginning of installation at the metering point, the module should be carefully taken out of the box where they were packed. This should prevent the module from falling as well as any other external or internal damage to the device and personal injuries. Should such an incident occur despite all precautions the module may not be installed at the metering point as such damage may result in different hazards. In such case, the module needs to be sent back to the manufacturer for examination and testing.

DO NOT OPEN THE MODULE COVER!

Opening of the module might result in defects and damages. In such a case, the warranty is not valid.

CAUTION: The edges of the seals, sealing wires as well as some edges under (removed) terminal cover are sharp!

DANGER: In case of any damage inside the meter/module (fire, explosion...) do not open the meter/module.

CAUTION: The meter/module may be used only for the purpose of measurement for which it was produced. Any misuse of the meter/module will lead to potential hazards.

WARNING: Safety measures should be observed at all times. Do not break the seals or open the meter/module at any time!

It must be consulted in all cases where symbol  is marked in order to find out the nature of the potential hazards and any actions, which have to be taken to avoid them.

The module and the meter installation procedure are described in the Installation and maintenance manual. For safety reasons, the following instructions should be followed.

See the complete Technical description for detailed technical features of the module and its intended use.

Only a properly connected meter/module can measure correctly! Every connection error could result in a financial loss for the power company!

1.2.2. Meter/module installation procedure

The installer must consult and comply with local regulations and read the installation instructions written in the Installation and maintenance manual before installation.

This Installation and maintenance manual provides the instructions for installing meters and modules. The document provides a short overview of the meter, details of device installation and set-up, installation considerations, and health and safety considerations.

The installer will be considered as a public face by both the power company and its customers. The installer shall adopt the highest standards of behaviour and be respectful to clients and members of the public.

Before the beginning of the installation procedure, check if the metering point is correctly prepared for meter installation. The metering point must always be left clean and in order.

The work location shall be defined and clearly marked. Adequate working space as well as means of access and lighting shall be provided at all parts of an electrical installation on, with, or near which any work activity is to be carried out.

Where necessary, safe access to the work location shall be clearly marked.

The metering point must not be exposed to running water or fire.

Meter/module installation may not be performed by unauthorised and untrained personnel. Such persons are not allowed to cut the seals and open the terminal or meter cover as contact with the live parts of the meter is dangerous for life.

CAUTION: On the supply side of installation where the meter is installed, the installer must provide environment according to requirements for OVC III or lower, so proper overvoltage protection must be installed (max. overvoltage <4kV). The protection must be done according to local regulation.

The installer must provide overcurrent protection on the supply side of installation. The cut off current of protection must not be higher than meter maximum current (I_{max}). The current capability of overcurrent protection must be according to UC rating of the meter equipment (only for direct connected meter). The overcurrent protection must be done according to local regulation as well.

The installer is responsible for coordinating the rating and the characteristics of the supply side overcurrent protection devices.

CAUTION: The installer is expected to fully understand the risks and safety issues involved in electrical installations. The installer shall be aware at all times of the potential hazard of electrical shock and shall exercise due caution in completing the task!

Tools, equipment, and devices shall comply with the requirements of relevant National or International Standards where these exist. Tools, equipment, and devices shall be used in accordance with the instructions and/or guidance provided by the manufacturer or supplier.

Any tools, equipment, and devices provided for the purpose of safe operation of, or work on, with, or near electrical installations shall be suitable for that use, be maintained and be properly used.

Personnel shall wear clothing suitable for the locations and conditions where they are working. This could include the use of close-fitting clothing or additional PPE (personal protective equipment).

CAUTION: The installer must be correctly equipped with personal protection equipment (PPE) and use the appropriate tools at all times during the installation.

Working procedures are divided into three different procedures: dead working, live working, and working in the vicinity of live parts. All these procedures are based on the use of protective measures against electric shock and/or the effects of short-circuits and arcing.

The installer must be informed if the national legislation permits the work on the installation under voltage – live work, and must follow the rules of legislation.

Depending on the kind of work, the personnel working in such conditions shall be instructed or skilled. Live working requires the use of specific procedures. Instructions shall be given how to maintain tools, equipment, and devices in good working order and how to verify them before working.

This subclause deals with the essential requirements (“the five safety or golden rules”) for ensuring that the electrical installation at the work location is dead and secure for the duration of the work.

This shall require clear identification of the work location. After the respective electrical installations have been identified, the following five essential requirements shall be undertaken in the specified order unless there are essential reasons for doing otherwise: disconnect completely (1.), secure against re-connection (2.), verify that the installation is dead (3.), carry out earthing and short-circuiting (4.), and provide protection against adjacent live parts (5.).

1.2.3. Module maintenance

No maintenance is required during the module’s lifetime. The implemented metering technique, built-in components, and manufacturing procedures ensure high long-term stability of meters and the modules. Therefore, no recalibration is required during entire meters lifetime.

In case the service of the module is needed, the requirements from the meter installation procedure must be observed and followed.

Cleaning of the module is allowed only with a soft dry cloth. Cleaning is allowed only in upper part of the module. Cleaning is forbidden in the back and side sites of the module. Cleaning can be performed only by the personnel responsible for meter/module maintenance.

CAUTION: Never clean soiled meters/modules under running water or with high-pressure devices. Penetrating water can cause short circuits. A damp cleaning cloth is sufficient to remove normal dirt such as dust. If the meter/module is more heavily soiled, it should be dismounted and sent to the responsible service or repair centre.

Visible signs of fraud attempt (mechanical damages, presence of a liquid, etc.) must be regularly checked.

The quality of seals and the state of the terminals and connecting cables must be regularly checked.

If there exists a suspicion of incorrect operation of the meter/module, the local utility must be informed immediately.

After the end of the meter's/module's lifetime, the meter/module should be treated according to the Waste Electric and Electronic (WEEE) Directive!

2. STANDARDS AND REFERENCES

DLMS UA 1000-2 Ed. 8.0:2014	DLMS/COSEM Architecture and Protocols, the “Green Book” Ed. 8
DLMS UA 1000-1 Ed. 12.0:2014	COSEM Identification System and Interface Classes, the “Blue Book” Ed. 12
EN 50065-1	Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz. General requirements, frequency bands and electromagnetic disturbances
EN 50065-2-3	Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 Khz. Immunity requirements for mains communications equipment and systems operating in the range of frequencies 3 kHz to 95 kHz and intended for use by electricity suppliers and distributors
EN 50065-7	Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148.5 kHz. Equipment impedance
EN 50470-1	Electricity metering equipment (a.c.) - Part 1: General requirements, tests and test conditions Metering equipment (class indexes A, B and C)
EN 55022	Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement
EN 60068-2-1	Environmental testing. Tests. Test A. Cold
EN 60068-2-2	Environmental testing. Tests. Test B. Dry heat
EN 60068-2-6	Environmental testing. Tests. Test Fc. Vibration (sinusoidal)
EN 60068-2-27	Environmental testing. Tests. Test Ea and guidance. Shock
EN 60068-2-30	Environmental testing. Tests. Test Db and guidance: Damp heat, cyclic (12 h + 12 h cycle)
EN 60068-2-75	Environmental testing. Tests. Test Eh: Hammer tests
EN 60085	Electrical insulation. Thermal evaluation and designation
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 60695-2-11	Glow wire flammability test for end products
IEC 61000-4-2	Electrostatic Discharge Immunity Test
IEC 61000-4-3	Radiated, radio-frequency, electromagnetic field immunity test
IEC 61000-4-4	Electrical Fast Transient / Burst Immunity Test
IEC 61000-4-5	Testing and Measurement techniques - Surge Immunity Test
IEC 61000-4-6	Electromagnetic compatibility (EMC) - Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8	Electromagnetic Compatibility (EMC) - Part 4-8: Testing and Measurement Techniques - Power Frequency Magnetic Field ImmunityTest
IEC 61000-4-11	Testing and Measurement Techniques - Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests
IEC 61000-4-12	Electromagnetic compatibility (EMC) - Part 4-12: Testing and measurement techniques - Ring wave immunity test
IEC 61000-4-20	Electromagnetic compatibility (EMC) - Part 4-20: Testing and measurement techniques - Emission and immunity testing in transverse electromagnetic (TEM) waveguides
IEC 62056-1-0 Ed.1:2016	Electricity metering – Data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardisation framework
IEC 62056-21 Ed. 1.0:2002	Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange

IEC 62056-46 Ed. 1.1:2007	Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol
IEC 62056-5-3: 2016	Electricity metering – Data exchange – The DLMS/COSEM suite – Part 5-3: DLMS/COSEM application layer
IEC 62056-6-1: 2015	Electricity metering – Data exchange - The DLMS/COSEM suite - Part 6-1: Object Identification System (OBIS)
IEC 62056-6-2: 2016	Electricity metering – Data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes
IEC 62056-9-7: 2013	Electricity metering – Data exchange – The DLMS/COSEM suite - Part 9-7: Communication profile for TCP-UDP/IP networks
ITU-T G.9901	Narrowband orthogonal frequency division multiplexing power line communication transceivers - Power spectral density specification (04/2014)
ITU-T G.9903	Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC networks (02/2014)
ITU-T G.9903	Narrowband orthogonal frequency division multiplexing power line communication transceivers for G3-PLC network - Amendment 1 (08/2015)
IEC 62056-4-7:2015	Electricity metering data exchange - The DLMS/COSEM suite - Part 4-7: DLMS/COSEM transport layer for IP networks
CLC/TS 52056-8-5: 2015	Electricity metering data exchange. The DLMS/COSEM suite. Narrow-band OFDM G3-PLC communication profile for neighbourhood networks

3. AC150-G3 – G3-PLC COMMUNICATION MODULE

3.1. Module description

AC150-G3 is an exchangeable communication module with G3-PLC interface. It operates automatically after it is inserted in Iskraemeco devices, which support the G3-PLC module.

The G3-PLC interface is designed according to G3-PLC specification and is intended as last mile interface for metering devices.

Figure 1: AC150-G3 module

3.2. Module type designation

AC150-G3.xy

AC	advanced communication
150	communication module
-	separator
G3	G3-PLC technology
.	separator (without if it is the 1st generation)
xy	product generation (if blank, it is the 1st generation

Table 1: Module type designation

3.3. Nameplate

Module nameplate (Figure 2) is laser printed on the front side of the module (module housing).

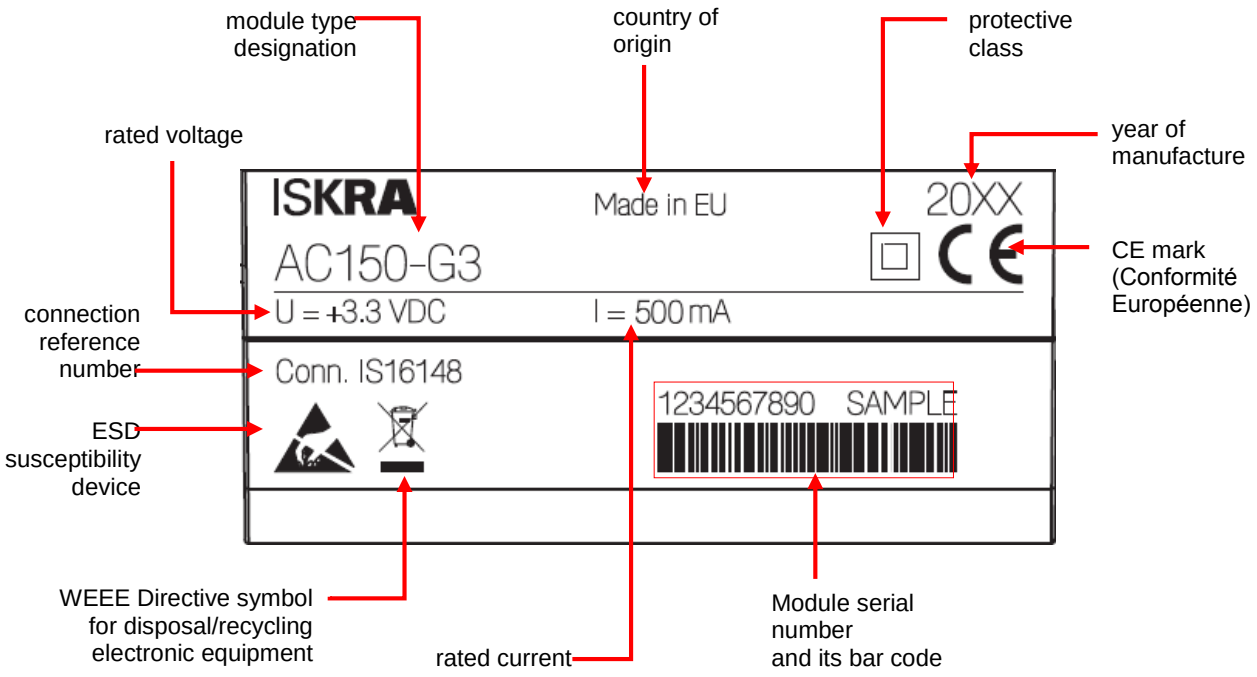

Figure 2: AC150-G3 module nameplate

3.4. Power supply

Power supply for the module is provided by the host device via the connector with DC rated voltage of 3.3 V and rated current of 500 mA.

3.5. Dimensions

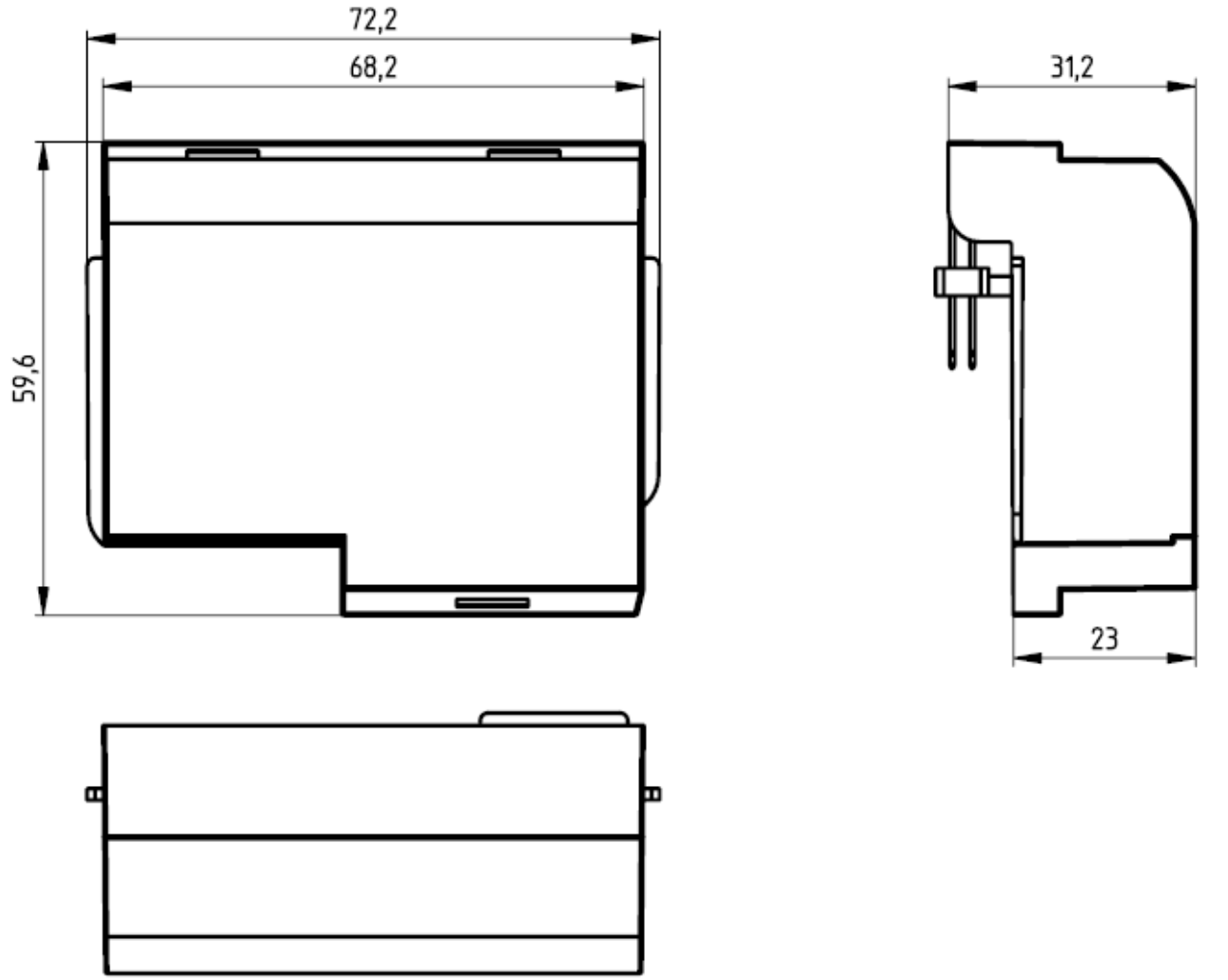

Figure 3: Overall dimensions of AC150-G3 module

3.6. Module connection

Connection reference number IS16148 is printed on the nameplate of the module (see the Figure 2). Pinout, pin designation, and reference number of connection can be found in the Figure 4.

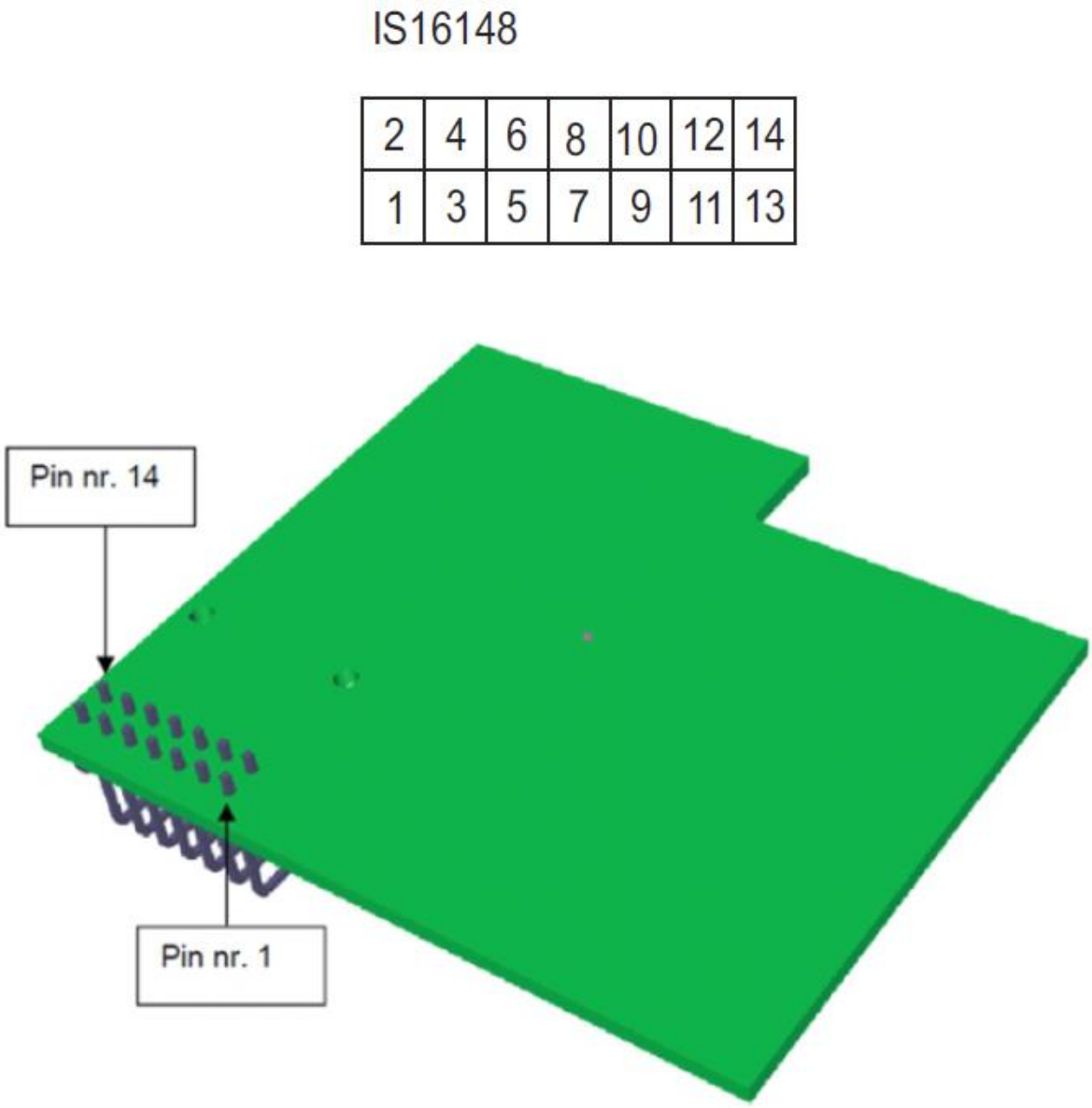

Figure 4: Pinout of the AC150-G3 module and reference number of connection diagram (IS16148)

4. ABOUT INSTALLATION

The Installation procedure is described in the documentation of the host device. Please read carefully the procedure before installing or removing the module.

NOTE

Electro Static electricity can harm some parts of the module/meter.
To prevent electro static damage, discharge static electricity from your body before the procedure. You can do so by touching an unpainted grounded metal surface.

NOTE

Please, do not remove module's PCBs from the plastic PCB cover!

WARNING

Only authorised personal should open the module cover.

WARNING

Because of the general safety issues, it is recommended that meter is unplugged from the electricity network before inserting/removal of module cover and communication modules.

DANGER

Only modules in original plastic housing can be inserted. It is live hazardous to insert only the module PCB.

5. MAIN MODULE FUNCTIONALITIES

5.1. Communication module detection

Communication modules are designed to be detected automatically. The modules may be exchanged either when the host device is not powered or during normal operation.

5.2. Communication module reset

In order to assure permanent communication capability without the need for human intervention, the module is constantly being monitored by the host device. In case that condition which would cause inability to communicate is detected, the module is being reset by the host device.

The reset is being triggered by a connection timeout, which is the time duration since the last successful communication between the HES (Head End System) and the device.

Connection timeout is parameter set by the object **0-1:94.31.2** in the meter.

5.3. Firmware upgrade

The communication module supports firmware upgrade. The upgrade is managed by the host device and is described in its documentation.

Firmware of the communication module is available in the **1-2:0.2.0** (Firmware identification) and **1-2:0.2.8** (Firmware signature) objects in the meter.

NOTE
Communication module Firmware signature is not supported by the meter. The object itself is visible, however without any value.

5.4. Security

The module is configured with PSK (Pre-Shared Key) which is written into the module during production. In order to join to the PLC network, the PSK shall be known to the PAN coordinator. Because of its secure nature, the PSK cannot be read from the Host device.

5.5. Alarms & Events

The module supports reading of alarms and events from the host device and additionally supports transferring alarms from the device to higher systems (Push notifications) via G3-PLC communication network.

NOTE
Alarms and events are described in the host device documentation.

5.6. Module configuration

Configuration of the module is performed from the host device. If the communication module is replaced the existing parameters will be automatically retrieved by the new communication module.

There are three objects, which contain the G3-PLC parameters and they are described in the next chapter.

5.6.1. G3 PLC Parameters

NOTE

OBIS (Object Identification System) code (according to DLMS UA 1000-1:2001 standard) is composed of 6 groups of digits (A-B:C.D.E*F; i.e. 0-0:1.0.0*255).

5.6.1.1. G3-PLC MAC layer counters

Logical name: **0-0:29.0.0*255,** (class_id = 90, version = 1)

Attributes	***Attribute description***	***R/W***	***Data type***	***Min.***	***Max.***	***Default***
1.logical_name	Identifies the “G3-PLC MAC layer counters” object instance.		octet-string	0		
2.mac Tx data packet_count	Statistic counter of successfully transmitted data packets (MSDUs).	R	double-long-unsigned	0	4 294 967 295	0
3.mac_Rx_data_ packet_count	Statistic counter of successfully received data packets (MSDUs).	R	double-long-unsigned	0	4 294 967 295	0
4.mac_Tx_cmd_ packet_count	Statistic counter of successfully transmitted command packets.	R	double-long-unsigned	0	4 294 967 295	0
5.mac_Rx_cmd_ packet_count	Statistic counter of successfully received command packets.	R	double-long-unsigned	0	4 294 967 295	0
6.mac_CSMA_fail_ count	Counts the number of times when CSMA backoffs reach macMaxCSMABackoffs.	R	double-long-unsigned	0	4 294 967 295	0
7.mac_CSMA_no_ ACK_count	Counts the number of times when an ACK is not received while transmitting a unicast data frame (The loss of ACK is attributed to collisions).	R	double-long-unsigned	0	4 294 967 295	0
8.mac_bad_CRC_ count	Statistic counter of the number of frames received with bad CRC.	R	double-long-unsigned	0	4 294 967 295	0
9.mac_Tx_data_ broadcast_count	Statistic counter of the number of broadcast frames sent.	R	double-long-unsigned	0	4 294 967 295	0
10.mac_Rx_data_ broadcast_count	Statistic counters of successfully received broadcast packets.	R	double-long-unsigned	0	4 294 967 295	0
Specific methods	***Specific methods description***		***m/o***			
1.reset (data)	This method forces a reset of the object. By invoking this method, the value of all counters is set to 0.		*o*			

Legend: R – read; W – write; m – mandatory; o – optional

Table 2: G3-PLC MAC layer counters

NOTE

When a counter reaches the maximum value (0xFFFFFFFF), it is automatically rolled-over.

5.6.1.2. G3-PLC MAC setup

Logical name: **0-0:29.1.0*255,** (class_id = 91, version = 1)

Attributes	*Attribute description*	*R/W*	*Data type*	*Min.*	*Max.*	*Def.*
1.logical_name	Identifies the “G3-PLC MAC setup” object instance.		octet-string			
2.mac_short_address	The 16-bit address the device is using to communicate through the PAN. Its value shall be equal to 0xFFFF when the device does not have a short address. An associated device necessarily has a short address, so that a device cannot be in the state where it is associated but does not have a short address.	R	long-unsigned	0x0000	0xFFFF	0xFFFF
3.mac_RC_coord (Mac route cost to coordinator)	Route cost to coordinator, to be used in the beacon payload as RC_COORD	R	long-unsigned	0x0000	0xFFFF	0xFFFF
4.mac_PAN_id	The 16-bit identifier of the PAN through which the device is operating. A value equal to 0xFFFF indicates that the device is not associated.	R	long-unsigned	0x0000	0xFFFF	0xFFFF
5.mac_key_table	This attribute holds GMK keys required for MAC layer ciphering. The attribute can hold up to two 16-bytes keys. The Key Identifier value must be different for each key. For security reason, the key entries cannot be read, only written.	R	array			
6.mac_frame_counter	The outgoing frame counter for this device, used when ciphering frames at MAC layer.	R	double-long-unsigned	0	4 294 967 295	0
7.mac_tone_mask	Defines the tone mask to use during symbol formation.	R/W	bit-string			0x0000 00000F FFFFF FFF
8.mac_TMR_TTL	Maximum time to live of tone map parameters entry in the neighbour table in minutes.	R/W	unsigned	0	255	2
9.mac_max_frame_ retries	Maximum number of retransmissions.	R/W	unsigned	0	10	5
10.mac_neighbour_ table_entry_TTL	Maximum time to live for an entry in the neighbour table in minutes.	R/W	unsigned	0	255	255
11.mac_neighbour_ table	The neighbour table contains information about all the devices within the POS of the device. One element of the table represents one PLC direct neighbour of the device. See ITU-T G.9903:2014 9.3.7.2 for CENELEC and FCC bands. **NOTE 1:** This table is actualized each time any frame is received from a neighbour device, and each time a Tone Map Response is received.	R/W	array			
12.mac_high_priority _window_size (High priority connection window size)	The high priority connetion window size in number of slots.	R/W	unsigned	1	7	7
13.mac_CSMA_ fairness_limit (MAC CSMA fail count)	Channel access fairness limit. Specifies how many failed back-off attempts, back-off exponent is set to minBE. This attribute can take a value between 2 × (macMaxBE – macMinBE) and 255.	R/W	unsigned	See the attribute description	255	25

Attributes	*Attribute description*	*R/W*	*Data type*	*Min.*	*Max.*	*Def.*
14.mac_beacon_ randomization_ window_length	Duration time in seconds for the beacon randomization.	R/W	unsigned	1	254	12
15.mac_A	This parameter controls the adaptive CW linear decrease.	R/W	unsigned	3	20	8
16.mac_K	Rate adaptation factor for channel access fairness limit. This attribute can take a value between 1 and macCSMAFairnessLimit.	R/W	unsigned	1	See the attribute description	5
17.mac_min_CW_ attempts	Number of consecutive attempts while using minimum CW.	R/W	unsigned	0	255	10
18.mac_cenelec_ legacy_mode	This read only attribute indicates the capability of the node. 0: The following configuration is used (legacy mode): - Elementary interleaving; - Interleaver parameters n_i and n_j are not swapped when I(i,j) = 0. 1: The following configuration is used (non legacy mode): - Full Block interleaving; - Interleaver parameters n_i and n_j are swapped when I(i,j) = 0.	R	unsigned	0	255	1
19.mac_FCC_legacy _mode	This read only attribute indicates the capability of the node. 0: The following configuration is used (legacy mode): - Differential FCH modulation; - Elementary interleaving; - Interleaver parameters n_i and n_j are not swapped when I(i,j) = 0; - Single RS block. 1: The following configuration is used (non legacy mode): - Coherent FCH modulation; - Full Block interleaving; - Interleaver parameters n_i and n_j are swapped when I(i,j) = 0; - Two RS blocks.	R	unsigned	0	255	1
20.mac_max_BE	Maximum value of backoff exponent. It should always be greater than macMinBE.	R/W	unsigned	0	20	8
21.mac_max_CSMA _backoffs	Maximum number of backoff attempts.	R/W	unsigned	0	255	50
22.mac_min_BE	Minimum value of backoff exponent.	R/W	unsigned	0	20	3
Specific methods	***Specific methods description***		***m/o***			
1.mac_get_neighbour _table_entry (data)	This method is used to retrieve the mac neighbour table for one MAC short address. It may be used to perform topology monitoring by the client. The method invocation parameter contains a mac_short_address.		o			

Legend: R – read; W – write; m – mandatory; o – optional

Table 3: G3-PLC MAC setup

5.6.1.3. G3-PLC MAC 6LoWPAN adaptation layer setup

Logical name: **0-0:29.2.0*255** (class_id = 92, version = 1)

Attributes	*Attribute description*	*R/W*	*Data type*	*Min.*	*Max.*	*Def.*
1.logical_name	Identifies the “G3-PLC OFDM 6LoWPAN adaptation layer setup” object instance.		octet-string			
2.adp_max_hops	Defines the maximum number of hops to be used by the routing algorithm.	R/W	unsigned	1	14	8
3.adp_weak_LQI_ value	The weak link value defines the LQI value below which a link to a neighbour is considered as a weak link. A value of 52 represents an SNR of 3 dB.	R/W	unsigned	0	255	52
4.adp_security_level	The minimum security level to be used for incoming and outgoing adaptation frames. Only values 0 (no ciphering) and 5 (ciphering with 32 bits integrity code) are supported.	R/W	unsigned	0	7	5
5.adp_prefix_table	Contains the list of prefixes defined on this PAN.	R	array			
6.adp_routing_ configuration	The routing configuration element specifies all parameters linked to the routing mechanism described in ITU-T G.9903:2014. The elements are specified in 9.4.1.2 of that Recommendation.	R/W	array			
7.adp_broadcast_ log_table_entry_TTL	Maximum time to live of an adpBroadcastLogTable entry (in minutes).	R/W	long-unsigned	0	65535	2
8.adp_routing_table	Contains the routing table.	R	array			
9.adp_context_ information_table	Contains the context information associated to each CID extension field.	R	array			
10.adp_blacklist_ table	Contains the list of the blacklisted neighbours.	R	array			
11.adp_broadcast_ log_table	Contains the broadcast log table. **NOTE 6**: This table provides a list of the broadcast packets recently received by this device.	R	array			
12.adp_group_table	Contains the group addresses to which the device belongs.	R	array			
13.adp_max_join_ wait_time	Network join timeout in seconds for LBD.	R/W	long-unsigned	0	1 023	20
14.adp_path_ discovery_time	Timeout for path discovery in seconds.	R/W	unsigned	0	255	40
15.adp_active_key_ index	Index of the active GMK to be used for data transmission.	R	unsigned	0	1	0
16.adp_metric_type	Metric Type to be used for routing purposes.	R/W	unsigned	0x00	0x0F	0x0F
17.adp_coord_short _address	Defines the short address of the coordinator.	R/W	long-unsigned	0x0000	0x7FFF	0x0000
18.adp_disable_ default_routing	If TRUE, the default routing is disabled. If FALSE, the default routing is enabled.	R/W	boolean			FALSE
19.adp_device_type	Defines the type of the device connected to the modem: - (0) PAN device, - (1) PAN coordinator, - (2) Not Defined	R/W	enum	0	2	2
Specific methods	***Specific methods description***		***m/o***			

Legend: R – read; W – write; m – mandatory; o – optional

Table 4: G3-PLC MAC 6LoWPAN adaptation layer setup

6. TECHNICAL DATA

6.1. AC150-G3 module properties

Communication profile – layers	
Physical: G3-PLC (ITU-T G.9903)	• CENELEC A Band (35 937.5 Hz – 90 625.0 Hz) • Up to 36 tones based on OFDM • Modulation: ROBO, DBPSK, DQPSK, D8PS • Data rate: 3192 - 43501 bits/s
Data Link: (IEEE 802.15.4)	• Security: AES-128 • CSMA-CA • ARQ • Link Adaptation - modulation type - tunes used
Network: LOADng routing (RFC3561, RFC6130 and RFC5444)	• Mesh • On-Demand • Ad-Hoc • Distance Vector • Next generation • Route repair Mechanism
Adaptation: 6LoWPAN (RFC4944)	• EAP-PSK Authentication • Packet Fragmentation • Header Compression

Table 5: Module properties

6.2. Power consumption

Consumption depends on network conditions specially network impedance; maximum total power delivered to the communication module is 1.7 W.

6.3. Environment conditions

Temperature ranges:

- operation: -40 °C to +70°C
- storage: -40 °C to +85 °C

Air humidity: max. 95%

Module IP protection class:

- unplugged: no protection
- plugged: according to the IP protection class of the supporting device.

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