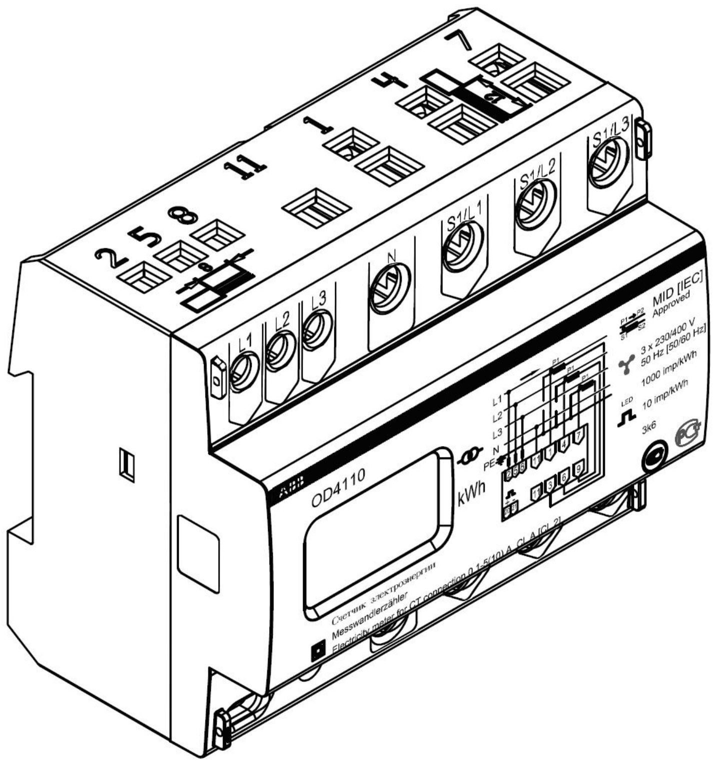

ODIN
User's Manual

Rev B

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TABLE OF CONTENTS

1 GENERAL

This manual contains information about the ODIN, which is a family of electronic electricity meters manufactured by ABB AB.

The purpose of this manual is to give the user a good overview and understanding of the functions and features that ODIN offers. It also describes general metering aspects. The end goal is to help the user to use the meter in the most optimal and correct way and to give the proper service and support to maintain the highest stability and lifetime.

The degree of the ODIN functions is controlled by its hardware (electronic boards, mechanics, etc), software (resided in a small computer inside the meter) and the meter type specific programming done when it is produced (stored in a non-volatile EEPROM memory).

Features (both hardware and software) which are not standard (incorporated in all meters) are pointed out in the manual as options.

WARNING! The voltages connected to the ODIN are dangerous and can be lethal. Therefore it must be insured that the terminals are not touched during operation. When installing the ODIN all voltages must be switched off.

2 PRODUCT DESCRIPTION

This chapter contains a description of the basic functions and practical handling of the ODIN. Functionality regarding communication is described in chapter 6.

2.1 FAMILY OVERVIEW

ODIN is an electronic electricity meter for 3-phase active energy metering intended for mounting on a DIN rail and is designed in accordance with the ABB ProM standard.

ODIN exists in 2 basic versions: One for direct metering up to 65A and one for transformer connected metering up to 10A. The LCD display has 7 digits, 6 mm high to ensure easy reading.

ODIN is made compact, only 6 modules to save space in the installation.

A red LED at the front flashes proportionally to the energy consumed.

ODIN has a temperature range from –25 to +55º C (storage +70º C).

ODIN has 3 ways to communicate:
- Display at front
- Pulse output
- IR interface for serial communication (together with serial communication adapter)

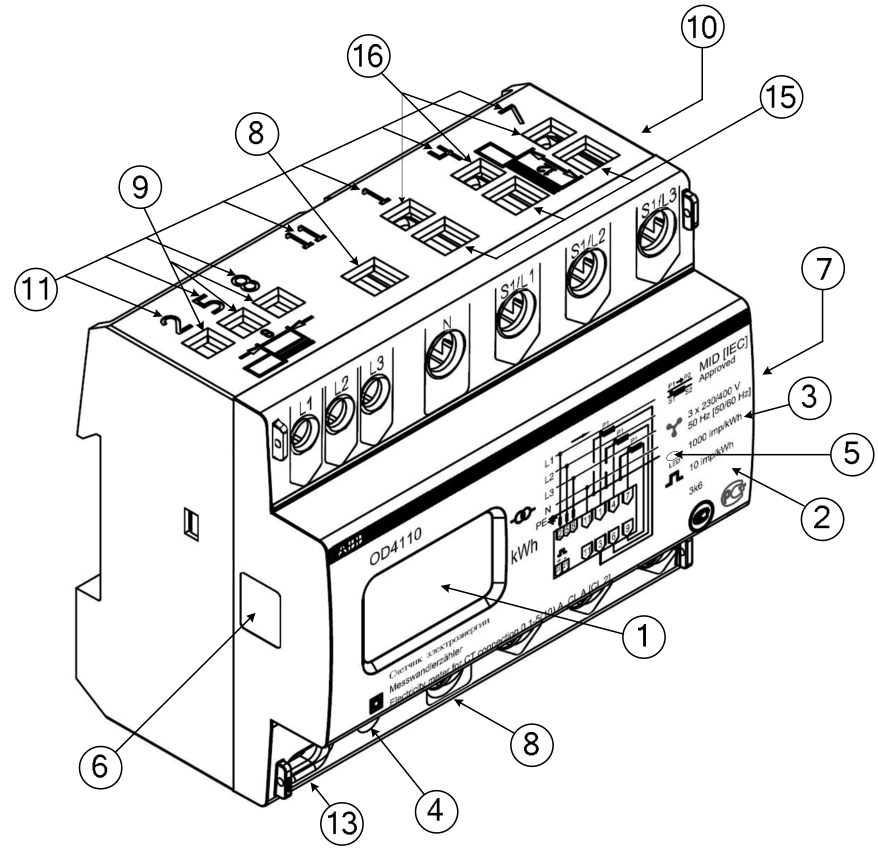
The ODIN transformer connected meter has one button that is used to set the current transformer ratio. The button can be sealed by mounting a sealable terminal cover or by mounting the ODIN in a modular enclosure.

ODIN meter types are tested and approved according to:
- IEC 62052-11 and 62053-21
- Measurement instrument directive (MID), category A and B, electrical environmental class E2 and electrical environmental class M2
- EN 50470-1, EN 50470-3 category A and B.

These standards cover technical aspects of the meter like climate conditions, electromagnetic compatibility (EMC), electrical requirements, mechanical requirements and accuracy.

2.2 METER PARTS

The different parts of the meter are depicted below, accompanied by a short description of each part.



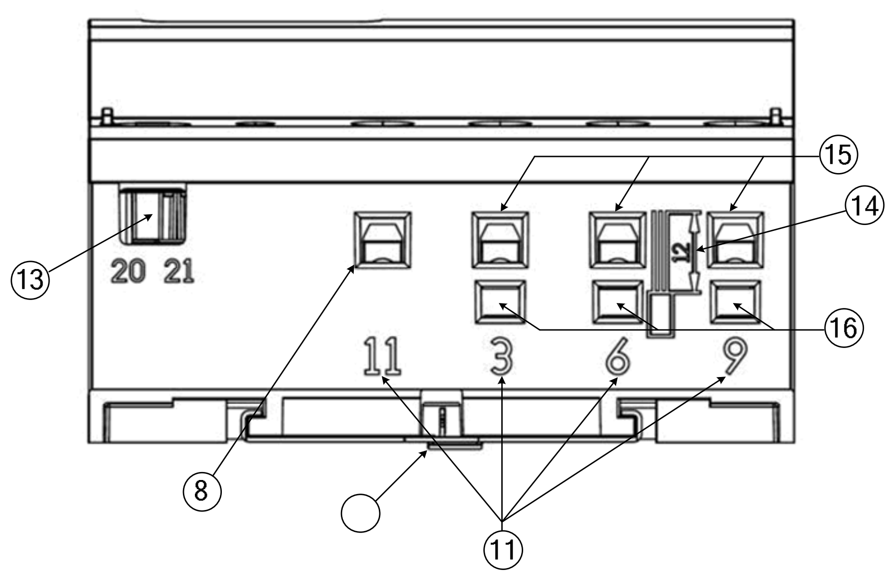


Fig. 2-1 Meter parts

-Position 1: LCD
A 7-digit Liquid Crystal Display.

-Position 2: Product information

-Position 3 and 5: LED and LED frequency
The meter has a red Light Emitting Diode that flashes in proportion to the consumed energy.

-Position 4: Button (only on transformer connected meter)
The button can be used to set the current transformer ratio

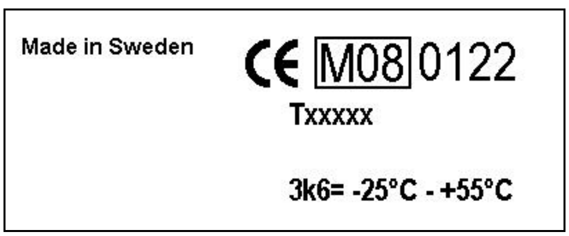
-Position 6: Optical port
For use of external communication devices.

-Position 7: Sealing tape
A piece of tape sealing the meter, which will leave traces on the meter in case it is broken.
It also serves as identification of our Accredited Laboratory for initial verification of the meter.

-Position 8: Neutral terminal
Made for stranded and flexible cables.

-Position 9: Voltage terminals (only on transformer connected meter)
The voltage measured by the meter is connected here.

-Position 10: Label fastened on the side of the meter with approval marks and temperature range:



-Position 11: Numbering of terminals

-Position 12: DIN-rail lock
Used for fixing the meter on the DIN-rail.

-Position 13: Pulse output
Terminals for pulse output.

-Position 14 Stripping length
Showing the stripping length of the cables.

-Position 15: Phase terminals
Made for stranded and flexible cables.

-Position 16: Phase terminals
Made for busbar system.

2.3 METER TYPES

The ODIN product family is divided into two types:

- Direct connected meters up to 65A
- Transformer connected meters up to 10A

The meter type is reflected on the product marking, see figure below.

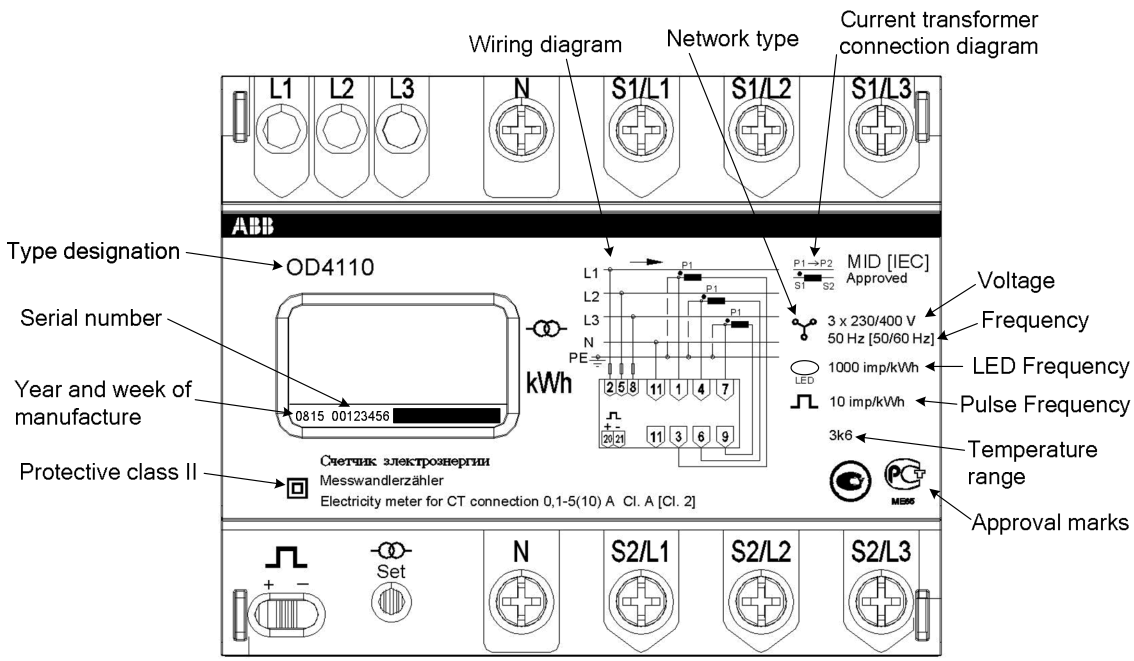


Fig. 2-2 Product label

A meter is identified by its type designation. For explanation of the positions in the type designation see further down in this chapter. IEC approval specific information is written within square brackets.

2.3.1 NETWORK TYPE

The network type symbol tells the number of measurement elements the meter contains. 3 voltages and 3 currents are measured and used in the energy measurement.

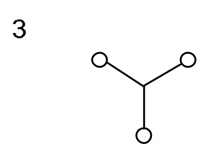


Fig. 2-3 Network symbol

The meter is used in 3-phase metering systems with 4 wires

2.3.2 TYPE DESIGNATION

ODIN

Pos	1-2	3	4	5-6
Base				
ODIN meter family	OD			
Network type				
4-wire, 3-phase system		4		
Functionality				
IR-port, pulse output			1	
Maximum current				
65A. Direct connected				65
10A. Transformer connected				10

2.4 ENERGY INDICATOR

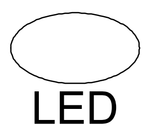


Fig. 2-4 Energy indicator

The red LED (Light Emitting Diode) on the front is an indicator that flashes in proportion to the energy. Every pulse means that a certain amount of energy has been registered, that is, it has a certain energy pulse frequency. This frequency is marked on the front of the meter.

2.5 BUTTON

The ODIN transformer connected meter has one button used to set the current transformer ratio.

2.6 DISPLAY INFORMATION

From the display it is possible to view information the energy consumption and various status information.

The display has 7 characters of 7-segment type with a height of 6 mm and a number of other specific segments to display different status information. The illustration below shows all segments (forming characters and symbols) that can appear on the display in different display modes.

2.6.1 DISPLAY OVERVIEW

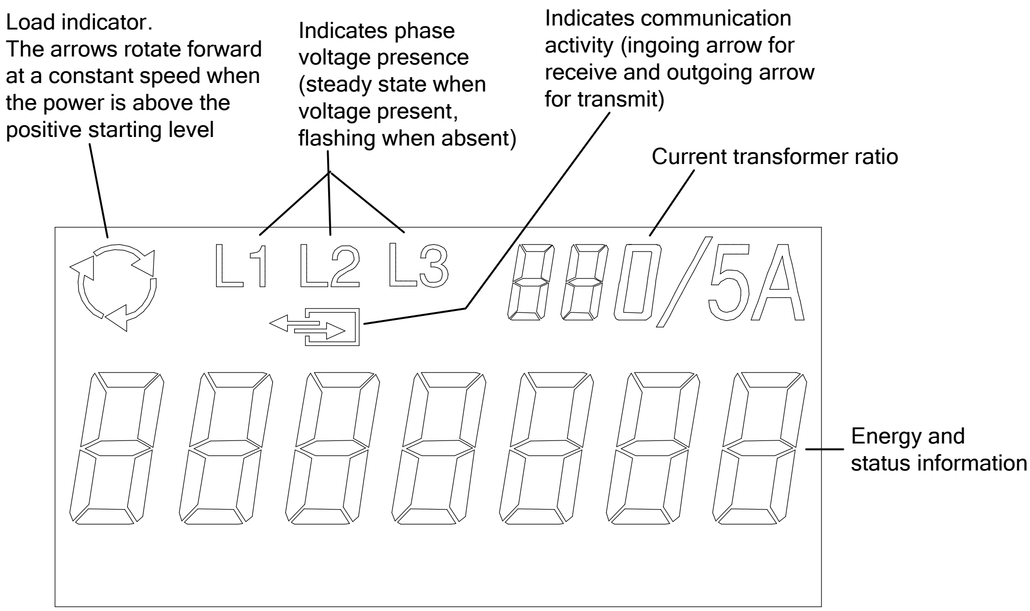


Fig. 2-5 ODIN meter LCD

2.6.2 7-SEGMENT CHARACTERS

All energy values are displayed by using the 7 segment 7 character segments. The figure below shows an example where the energy (21583 kWh) is displayed.

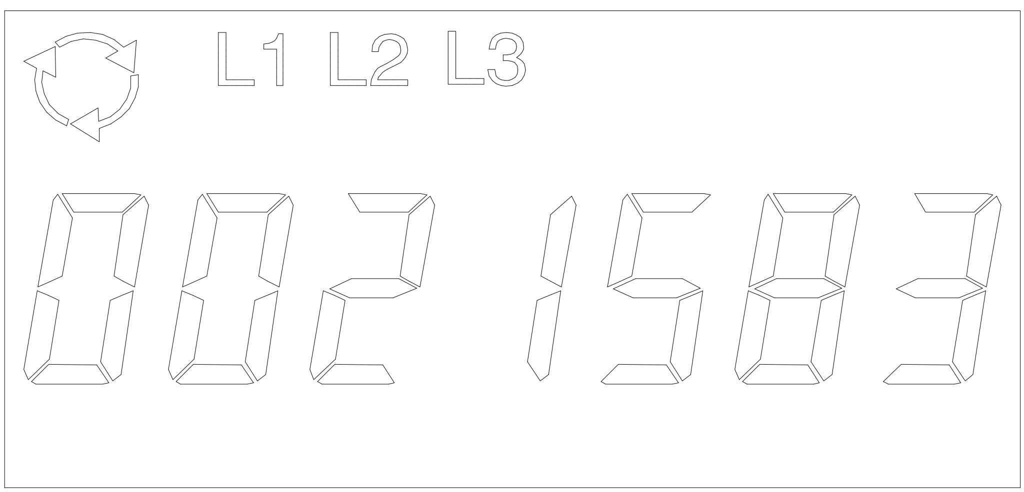


Fig. 2-6 Display of active energy

2.6.3 LOAD INDICATOR

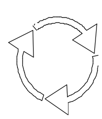


Fig. 2-7 Load indicator

There are three arrows, which will rotate as soon as the power is above the start level. The rotating speed is constant and independent of the measured energy. If the metering is below the start level all the arrows are constantly on and not rotating.

If the energy is positive the arrows are rotating in the forward direction and if the energy is negative the arrows are not rotating.

2.6.4 COMMUNICATION STATUS

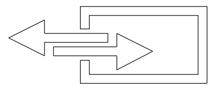


Fig. 2-8 Communication status

The M-bus communication status is indicated by the communication segments on the LCD which consists of two arrows going into and out of the meter (illustrated as a box). When the meter detects a valid message addressed to itself it sets the receive segment on (the arrow going into the box) and when it sends out a message it sets the transmit segment on (the arrow going out of the box).

2.7 DISPLAY SYSTEM

The ODIN meter display system is dependant on the type of meter it is. In transformer connected meters the current transformer ratio is displayed which is not displayed in direct connected meters. Some information are always displayed on the LCD, irrespective of active mode. Below in the figure is depicted the display system and the different information displayed.

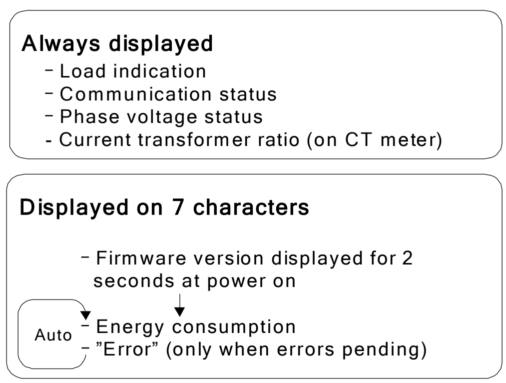


Fig. 2-9 Display system

If errors are pending the energy and the error indication are displayed sequentially and automatically one at a time. The energy is displayed for 3 seconds and "Error" for 3 seconds.

At power on the firmware version is displayed for 2 seconds in the format "XXX-YYY" where XXX is the total version and YYY is the metrological version. For example, version 1.05-1.00 is displayed as "105-100".

2.8 CURRENT TRANSFORMER RATIO

On transformer connected ODIN meters it is possible to choose a current transformer ratio from a set of predefined values. It is assumed that a current transformer with nominal secondary current 5 A is used and the ratios to choose from are: 5/5, 75/5, 100/5, 150/5, 200/5, 250/5, 300/5, 400/5, 500/5, 600/5, 700/5, 750/5, 800/5 and 900/5.

The current transformer ratio, which is displayed in the upper right corner of the LCD, is changed to the next value in the list for each press of the button.

Below in the figure is an example where the current transformer ratio 750/5 have been selected.

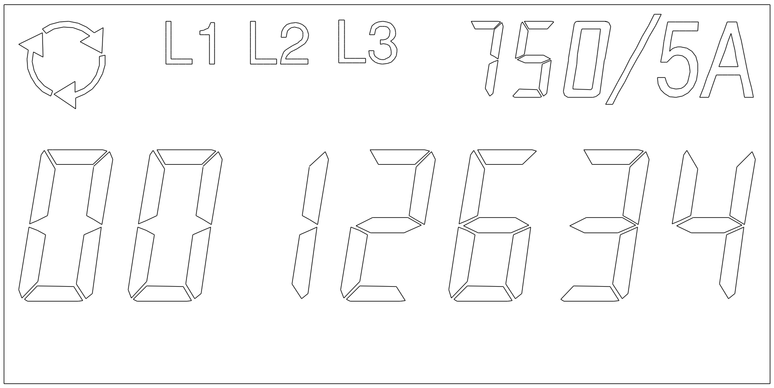


Fig. 2-10 Display of current transformer ratio 750/5

The meter is using the selected current transformer ratio in the energy calculation to calculate, display and register the primary energy consumed.

2.9 PULSE OUTPUT

The ODIN meter is equipped with a pulse output for active energy. The pulse output sends out a certain amount of pulses per kilowatt hour. In transformer connected meters the pulse output is primary registering (uses the selected current transformer ratio in the energy calculation).

The pulse output is galvanically isolated from the rest of the electronics in the meter.
It fulfils the IEC standard 62053-31 and DIN 43 864 standard (often called S0). The output has a maximum voltage and current specified to 40 Volt DC and 100 mA. It is built with a transistor and an optocoupler of transistor type and is polarity dependent. The equivalent circuitry of the output is depicted below.

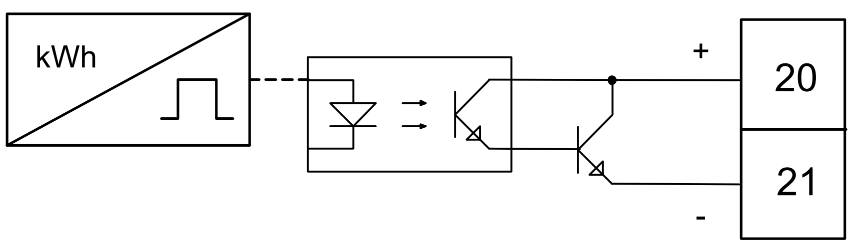


Fig. 2-11 Pulse output equivalent schematic diagram

2.10 ELECTRONICS

The energy measuring is realized electronically, see figure below where the electronics is depicted in a block diagram.

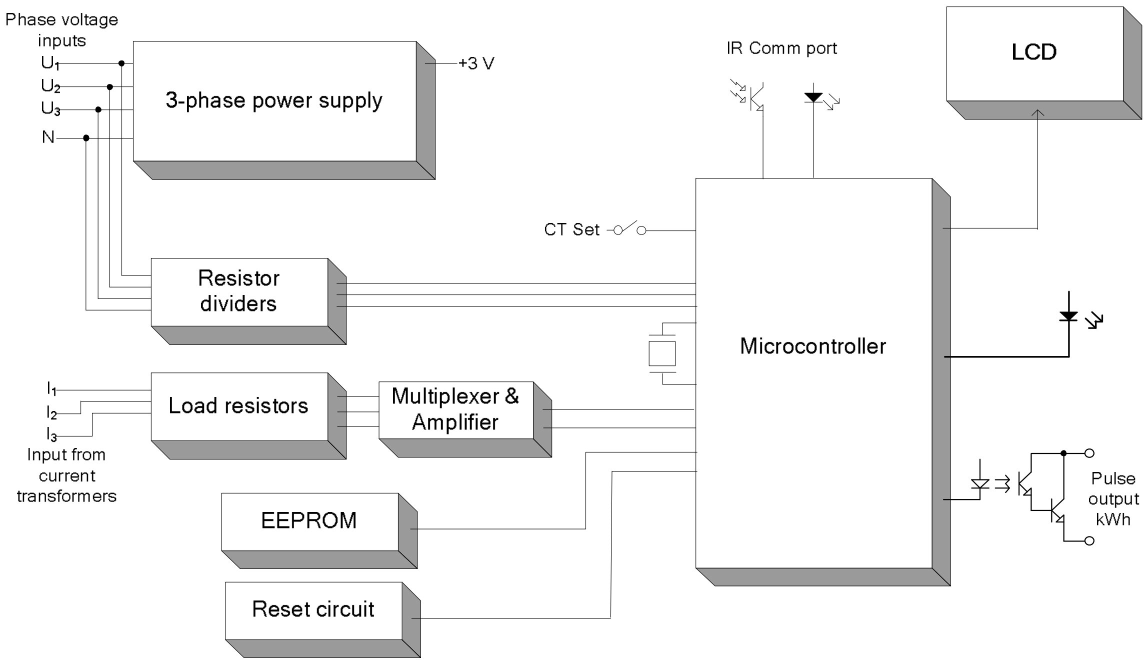


Fig. 2-12 Electronics block diagram

The meter hardware can be divided into the following parts:

- The mains voltages are divided by a resistor dividers and fed into the microcontroller.
- The currents are measured with current transformers (CT's) through which the currents to measure flows. The output current from the transformers flows through load resistors which produces voltages which are fed to the microcontroller. At low currents the signal is amplified with a programmable amplifier.
- A microcontroller that performs the energy calculation. The voltage and current signals are sampled by A/D-converters incorporated in the microcontroller and multiplied together digitally to get the energy. The meter is calibrated via registers to fulfil the accuracy class requirements stated in the standards. The microcontroller also handles the LCD, EEPROM, red LED, programmable amplifier, infrared (IR) communication interface, the button and the pulse output.
- An LCD (liquid crystal display) for display of accumulated energy, transformer ratio and status information.
- 1 push button for setting of current transformer ratio in transformer connected meters
- An oscillator that clocks the microcontroller.
- A 3-phase power supply that generate 3V for feeding the electronics (microcontroller, EEPROM etc).
- A red LED (light emitting diode) that flashes with a certain energy pulse frequency (impulses/kWh).
- 1 optoisolated pulse output which give a certain amount of pulses per kWh.
- An EEPROM for storing energy, calibration- and initialization values for the microcontroler and for meter specific values which are used by the firmware in the microcontroller. The data retention time for stored data in the EEPROM is more than 100 years.

- An infra-red communications-interface consisting of a phototransistor and a LED for connection to an external communication unit.

2.11 DIMENSIONS

Below the dimensions for the meter are displayed.

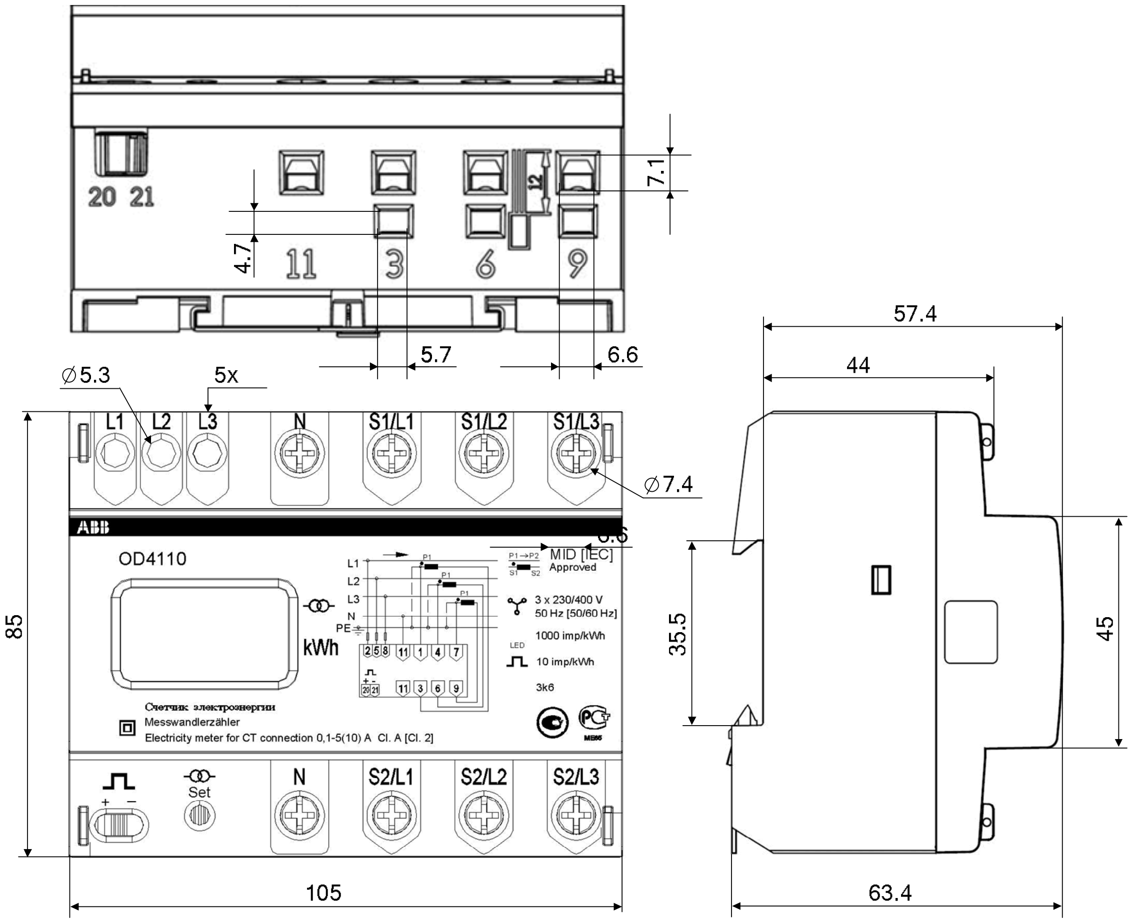


Fig. 2-13 Meter dimensions

3 TECHNICAL DATA

3.1 VOLTAGE

Nominal voltage U_n:	3 x 220-240 / 380-416 VAC (4-wire, 3-element)
Voltage range of U_n:	-20% to +15%

3.2 CURRENT

Min current I_{min}:	0.25 A for direct connected meter, 0.10 A for transformer connected meter
Min current inside class I_{tr}:	0.5 A
Reference alt. Base current I_{ref} (I_b):	5 A
Maximum current I_{max}:	65 A for direct connected meter, 10 A for transformer connected meter
Starting current I_{st}:	20 mA

3.3 GENERAL DATA

Frequency f_n:	50/60 Hz
Frequency range of f_n:	+/-5%
Accuracy Class:	A (Cl. 2)
Power consumption at 230 VAC and 5 A:	1.0 VA per phase

3.4 STANDARDS

MID approval according to:	EN 50470-1, EN 50470-3 class A
International approvals according to:	IEC 62052-11, IEC 62053-21 class 2

3.5 TEMPERATURE RANGE

Operating:	-25 to +55 ˚C (3k6)
Storage:	-25 to +70 ˚C

3.6 ENCLOSURE MATERIAL

Top cover:	Polycarbonate
Bottom cover:	Polycarbonate/glass fibre
Glow wire test according to:	IEC 695-2-1

3.7 ENVIRONMENTAL CLASSES

Insulation protective class:	Class II
Mechanical environment:	M2
Electromagnetical environment:	E2
Resistance to heat and fire:	IEC 60695-2-10 to 11, Terminal (bottom cover) 960˚C, Cover 650˚C
Humidity:	75% yearly average, 95% on 30 days/year
Protection against penetration of dust and water:	IP20 on terminals, IP 51 when mounted in protective enclosure.

3.8 CONNECTION AREA MAIN TERMINALS

Current and main terminals:	Flexible or stranded 1 – 16 mm
Recommended tightening torque:	2 Nm

3.9 PULSE OUTPUT

Connection area:	Flexible, 0 - 2.5 mm², Solid 0 - 2.5mm²
Recommended tightening torque:	0.5 Nm
External pulse voltage:	5 – 40 V (DC), (Transistor output, polarity dependent)
Max. current:	100 mA
Pulse length:	100 (± 2,5) ms
Pulse frequency:	100 imp/kWh on direct connected meter,

	10 imp/kWh (primary recording) on transformer connected meter
Standard:	IEC 62053-31 (S0)

3.10 LED

Pulse frequency:	100 imp/kWh on direct connected meter, 1000 imp/kWh on transformer connected meter
Pulse length:	40 ms

3.11 DISPLAY OF ENERGY

LCD with 7 digits, 6mm high, without a decimal place

3.12 DIMENSIONS AND WEIGHT

Width: 105 mm, 6 DIN modules
Height: 85 mm.
Depth: 63.4 mm.
Weight: 0.38 kg for direct connected meter,
0.40 kg for transformer connected meter

3.13 ELECTROMAGNETIC COMPABILITY

Impulse voltage test:	6 kV, (IEC 60060-1), (HD 588.1 S1)
Fast transient burst test:	4 kV, (IEC 61000-4-4)
Immunity to electromagnetic HF-fields:	80Mhz – 2 GHz (IEC 61000-4-3)
Immunity to conducted disturbance:	150kHz – 80MHz, (IEC 61000-4-6)
Radio frequency emission:	EN 55022, class B (CISPR22)
Electrostatic discharge (ESD)	15 kV, (IEC 61000-4-2)

4 INSTALLATION

WARNING! The voltages connected to the ODIN meter are dangerous and can be lethal. Therefore all voltages must be switched off when installing the ODIN meter. Do not operate the ODIN meter outside the specified technical data. Installation and commissioning may only be carried out by authorised electrical specialists. The installer is responsible that the electricity meter is correctly and safely installed.

To comply with the protection requirements the meter must be mounted in a class IP51 enclosure or better, according to IEC 60529.

4.1 MOUNTING

The ODIN can be mounted in different ways. Below is described the most common ways.

For some of the mounting alternatives additional accessories are needed (for part numbers see chapter 7).

4.1.1 DIN-RAIL MOUNTED

The ODIN is aimed to be mounted on a DIN-rail designed according to the standard CEI/IEC 715. In this case no extra accessories are needed and the meter is fastened on the rail so that the metal snap piece on the back of the meter snaps onto the rail.

4.2 WIRING DIAGRAMS

Below is described how to connect the meters to the electricity network. The ODIN must always be protected by fuses on the incoming side.

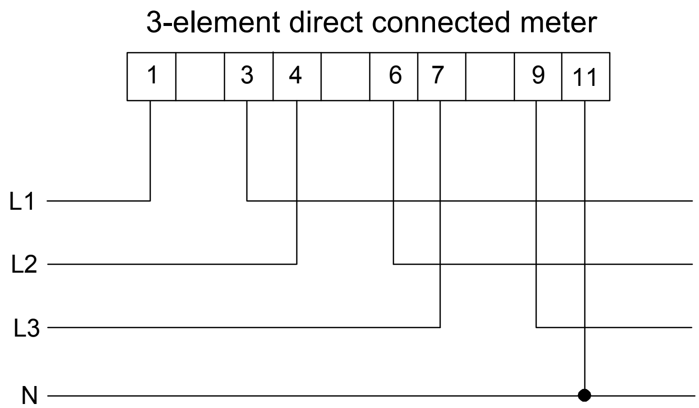


Fig. 4-1 Wiring diagram for direct connected meter

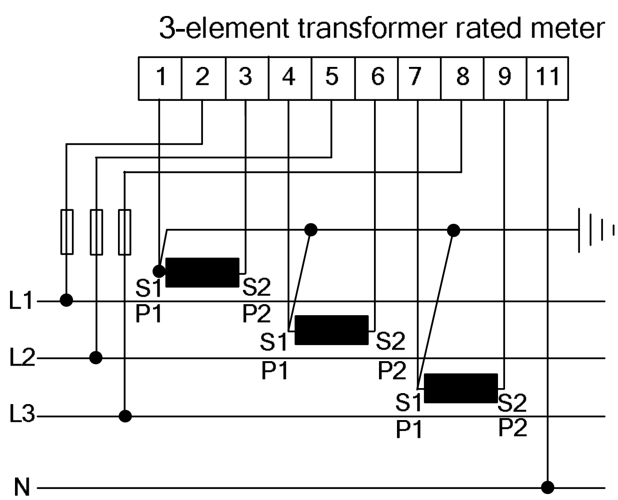


Fig. 4-2 Wiring diagram for transformer connected meter

4.2.1 PULSE OUTPUT

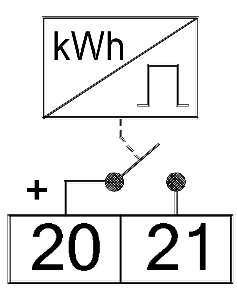
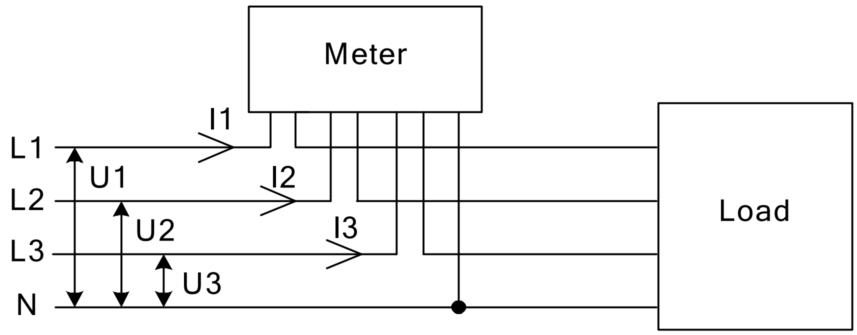


Fig. 4-3 Pulse output connection diagram

5 MEASUREMENT METHOD

ODIN is a 3-phase, 3-element meter measuring the active energy consumption in a 4-wire installation, see figure below.



$$E = \int (U1(t) \bullet I1(t) + U2(t) \bullet I2(t) + U3(t) \bullet I3(t)) \bullet dt$$

Fig. 5-1 3-element measurement

The metering calculation in the meter is done digitally by a microcontroller according to the formula:

$$E = \sum_{n=0,1,2...} k1 \bullet u1(n \bullet T) \bullet i1(n \bullet T) + k2 \bullet u2(n \bullet T) \bullet i2(n \bullet T) + k3 \bullet u3(n \bullet T) \bullet i3(n \bullet T)$$

k1-k3 are a calibration constants, u1-u3 the phase voltages and i1-i3 the phase currents. The voltage and current signals are sampled regularly (once every time interval T) by an analog-to-digital converter and via software multiplied together to give an amount of energy. This energy is accumulated to an energy register E which keeps track of the total energy. In the transformer connected meter the current is multiplied by the current transformer ratio to give the primary energy.

6 COMMUNICATION

Reading a meter through a communication interface gives a number of advantages compared to manual reading:

- The time it takes to read a number of meters is much shorter. It is also possible to perform continuous readings.
- The risk of getting wrong values because of mistakes during manual reading is reduced to a minimum.
- The values are stored electronically, which makes it easier to process them further.

All ODIN have an optical interface on the left side of the meter. For communication via the optical interface the M-Bus protocol is used.

This chapter describes the M-Bus communication.

6.1 M-BUS

The M-Bus (Meter Bus) is a bus system for the remote reading of meters. It is a master-slave system for communication on twisted pair where all meters are slaves.

6.1.1 COMMUNICATION OBJECTS

Communication objects in the ODIN meter are listed in table below.

Register	Description
Total active energy	Cumulative total active energy
Manufacturing information	Manufacturer code, serial number, status information etc located in telegram header
Transformer ratio	Current transformer ratio set by button on meter and displayed on LCD
Firmware version	Firmware version of program code in the meter (sent out only on meters with protocol version 7 or higher)

6.1.2 PHYSICAL INTERFACE

The physical interface uses serial half-duplex asynchronous communication. Since the bus has a master-slave structure, where there must and can be only one master, the meters cannot communicate with each other.

6.1.2.1 Optical interface

The ODIN has an optical interface located on the left side. Physical characteristics of the interface correspond to the standard IEC 61107. Communication speed is 2400 bps.

6.1.3 PROTOCOL DESCRIPTION

The M-Bus protocol is based on the international standard IEC 870, but it does not use all of its specified functions.

When there is no communication on the bus it is in Mark-state.

Each communicated byte consists of eleven bits. The bits are one start-bit (space), eight data bits, one parity bit (even) and one stop bit (mark). The least significant bit is transmitted first.

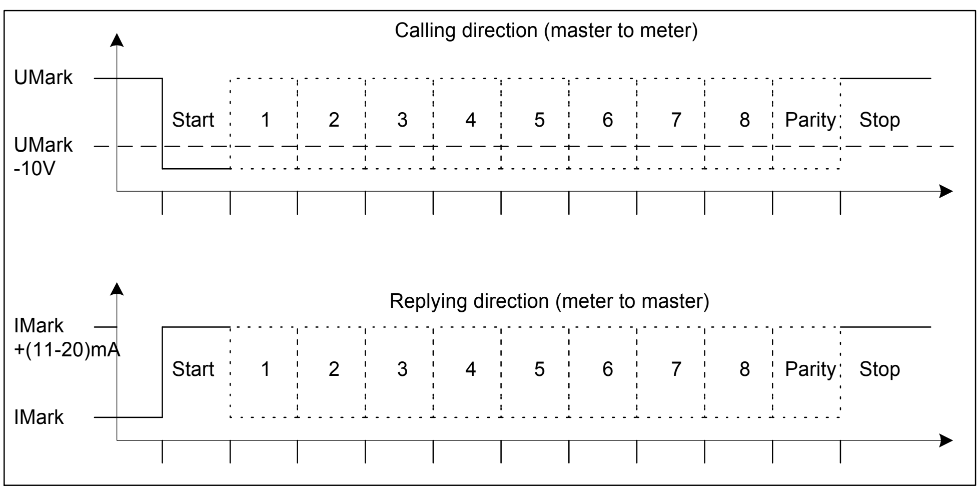


Fig. 6-1 Transmission of a Character in Calling and Replying Direction

6.1.3.1 Telegram formats

The telegram formats are structured according to format class FT1.2. The FT1.2 format fulfils the data integrity class I2, including a hamming distance of four. Three telegram formats are used. The start character identifies the different telegram formats.

Single Character	Short Frame	Long Frame
E5h	Start (10h)	Start (68h)
	C-field	L-field
	A-field	L-field
	Check Sum	Start (68h)
	Stop (16h)	C-field
		A-field
		CI-field
		User Data (0-252 byte)
		Check Sum
		Stop (16h)

Telegram Formats

- **Single character** - The Single character format consists of a single character (E5h) and is used to acknowledge received telegrams.
- **Short frame** - The Short frame format is identified by its start character (10h) and consists of five characters. Besides the C- and A-fields it includes the checksum and the stop character 16h.
- **Long frame** - The Long frame format is identified by its start character (68h) and consists of a variable number of characters. After the start character the L-field is transmitted twice, then the start character once again followed by the C-, A- and CI-fields. The user data (0 - 252 bytes) is transmitted after the CI-field followed by the check sum and the stop character (16h).

6.1.3.1.1 Field descriptions

All fields used in the telegram frames have a length of one byte (8 bits).

- Length field (L-field)
The L-field gives the quantity of the user data inputs plus 3 (for the C-, A- and CI-fields). It is transmitted twice in telegrams using the long frame format.

- Control field (C-field)
The C-field contains information of the direction of the data flow, error handling and besides labeling the functions and the actions caused by them, the control field specifies the direction of data flow, and is responsible for various additional tasks in both the calling and replying directions.

Bit number	7	6	5	4	3	2	1	0
To the meter	0	PRM	FCB	FCV	F3	F2	F1	F0
From the meter	0	PRM	0	0	F3	F2	F1	F0

Coding of the Control Field

- The primary message bit (PRM) is used to specify the direction of data flow. It is set to 1 when a telegram is sent from a master to the meter and to 0 in the other direction.
- The frame count bit valid (FCV) is set to 1 by the master to indicate that the frame count bit (FCB) is used. When the FCV is set to 0, the meter ignores the FCB.
- The FCB is used to indicate successful transmission procedures. A master shall toggle the bit after a successful reception of a reply from the meter. If the expected reply is missing, or the reception of it is faulty, the master resends the same telegram with the same FCB. The meter answers, to a REQ_UD2-request with toggled FCB and a set FCV, with a RSP_UD containing the next telegram of a multi-telegram answer. If the FCB is not toggled it will repeat the last telegram. The actual values will be updated in a repeated telegram. On receipt of a SND_NKE the meter clears the FCB. The meter uses the same FCB for primary addressing, secondary addressing and point-to-point communication.
- The bits 0 to 3 (F0, F1, F2 and F3) of the control field are the function code of the message.

Name	C-field (binary)	C-field (hex)	Telegram	Description
SND_NKE	0100 0000	40	Short Frame	Initialization of Meter
SND_UD	01F1 0011	53/73	Long Frame	Send User Data to Meter
REQ_UD2	01F1 1011	5B/7B	Short Frame	Request for Class 2 Data
RSP_UD	0000 1000	08	Long Frame	Data Transfer from Meter to Master after Request

Function Codes

- Address Field (A-field)
The address field is used to address the recipient in the calling direction, and to identify the sender of information in the receiving direction. The size of this field is one byte, and can therefore take values from 0 to 255.

- The address 0 is given to meters at manufacturing.
- The addresses 1 to 250 are given to the meters as individual primary addresses. The address can be set via the bus (see chapter 6.1.4.3.1).
- The addresses 251 and 252 are reserved for future use.
- The address 253 (FDh) is used by the secondary addressing procedure.
- The address 254 (FEh) is used for point-to-point communication. The meter replies with its primary address.
- The address 255 (FFh) is used for broadcast transmissions to all meters. None of the meters replies to a broadcast message.

- Control Information Field (CI-field)
The CI-field codes the type and sequence of application data to be transmitted in the frame. Bit two (counting begins with bit 0, value 4), called M-bit or Mode bit, in the CI-field gives information about the used byte sequence in multi-byte data structures. For communication with the ODIN meter, the Mode bit shall not be set (Mode 1) meaning the least significant byte of a multi-byte record is transmitted first.

CI	Application
51h	Data send
52h	Selection of slaves

CI-field codes to use by the master

The meter uses code 72h in the CI-field for responses to requests for user data.

-User Data
The User Data contains the data to be sent to the recipient.

Fixed Data Header	Data Records	MDH
12 Byte	Variable number of bytes	1 Byte

Structure of the User Data meter to master

Data Records
variable number of bytes

Structure of the User Data master to meter

Fixed Data Header

Identification No	Manufacturer	Version	Medium	Access No	Status	Signature
4 Byte	2 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Byte

Structure of the Fixed Data Header

- **Identification Number** is the 8-digit serial number of the meter (BCD coded).
- **Manufacturer** is set to 0442h meaning ABB.
- **Version** specifies the version of the protocol implementation.
- **Medium** byte is set to 02h to indicate electricity.
- **Access Number** is a counter that counts successful accesses.
- **Status** byte is used to indicate the meter status.

Bit	Meaning
0	Meter busy
1	Internal error
2	Power low
3	Permanent error
4	Temporary error
5	Installation error [1)]
6	NOT USED
7	NOT USED

[1)] Manufacturer specific

- **Signature** is set to 00 00h.

Data Records
The data, together with information regarding coding, length and the type of data is transmitted in data records. The maximum total length of the data records is 234 bytes.

Data Record Header (DRH)				Data
Data Information Block (DIB)		Value Information Block (VIB)		
DIF	DIFE	VIF	VIFE	
1 Byte	0-10 Bytes	1 Byte	0-10 Bytes	0-n Bytes

Structure of a Data Record (transmitted from left to right)

Each data record consists of a data record header (DRH) and the actual data. The DRH in turn consists of the data information block (DIB) to describe the length, type and coding of the data, and the value information block (VIB) to give the value of the unit and the multiplier.

Data Information Block (DIB)
The DIB contains at least one byte (Data Information Field, DIF), and is in some cases expanded with, a maximum of 10, DIFE's (Data Information Field Extension).

Bit 7	6	5	4	3	2	1	0
Extension Bit	LSB of storage number	Function Field		Data Field : Length and coding of data			

Structure of the Data Information Field (DIF)

- The **Extension Bit** is set when next byte is a DIFE.
- The **LSB of storage number** is normally set to 0 to indicate actual value (1 = stored value).
- The **Function Field** is always set to 00 indicating instantaneous value.
- The **Data Field** shows the format of the data.

Code	Meaning	Length in Byte
0000	No data	0
0001	8 Bit Integer	1
0010	16 Bit Integer	2
0100	32 Bit Integer	4
0111	64 Bit Integer	8
1010	4 digit BCD	2
1011	6 digit BCD	3
1100	8 digit BCD	4
1101	Variable length (ASCII)	Variable
1110	12 digit BCD	6

Coding of the Data Field

Bit 7	6	5	4	3	2	1	0
Extension Bit	Unit	Tariff		Storage Number			

Structure of the Data Information Field Extension (DIFE)

- The **Extension Bit** is set when next byte is a DIFE.
- **Unit** is used on power and energy values to tell what type of power/energy the data is. Always set to 0 in ODIN.
- **Tariff** is used on energy values to give tariff information (0 = Total, 1 = Tariff 1). 0 is used for the total (non-resettable) energy and 1 is used for the resettable) energy.
- **Storage Number** is used to indicate an instantaneous or stored (historical) value (>0 = stored value). Always set to 0 in ODIN.

Value Information Block (VIB)

The VIB follows a DIF or DIFE without a set extension bit. It contains one Value Information Field (VIF) and is in some cases expanded with up to 10, Value Information Field Extensions (VIFE).

Bit 7	6	5	4	3	2	1	0
Extension Bit	Value Information						

Structure of the Value Information Field (VIF)

Value Information contains information about the value (unit, status etc).
The Extension Bit is set when next byte is a VIFE.

In case VIF or VIFE = FFh the next VIFE is manufacturer specific. The manufacturer specific VIFE has the same construction as a VIF. If the extension bit of the manufacturer specific VIFE is set, and the VIFE is less than 1111 1000, the next byte is a standard VIFE, otherwise it is the first data byte. If the extension bit of the manufacturer specific VIFE is set and the VIFE is bigger or equal to 1111 1000, the next byte is an extension of manufacturer specific VIFE’s.

VIF-Code	Description	Range Coding	Range
E000 0nnn	Energy	$10^{(nnn-3)}$ Wh	0.001Wh to 10000Wh
E111 1010	Bus Address		0 to 250
1111 1011	Extension of VIF-codes		Not used by ODIN
1111 1101	Extension of VIF-codes		True VIF is given in the first VIFE and is coded using Table FD
1111 1111	Manufacturer Specific		Next VIFE is manufacturer specific

Codes for Value Information Field (VIF)

Codes for Value Information Field Extension (VIFE) used with extension indicator FDh
If the VIF contains the extension indicator FDh the true VIF is contained in the first VIFE.

VIFE-Code	Description
E000 1110	Firmware Version

Table FD

Codes for Value Information Field Extension (VIFE)
The following values for VIFE's are defined for an enhancement of VIF's other than FDh and FBh:

VIFE-Code	Description
1111 1111	Next VIFE is manufacturer specific

VIFE-Codes for reports of record errors (meter to master)

VIFE-Code	Type of Record Error	Error Group
E000 0000	None	
E001 0101	No data available (undefined value)	
E001 1000	Data error	Data Errors

Data
The Data follows a VIF or a VIFE without the extension bit set.

Manufacturer Data Header (MDH)
The manufacturer data header (MDH) is made up by the character (0Fh or 1Fh). 1Fh indicates that more data will follow in the next telegram. 0Fh indicates that all data has been read.

Manufacturer specific data
Manufacturer specific data is sent immediately after the MDH. The commands are sent using SND_UD. The syntax for the commands is [VIF (2 bytes)][data (0-196 bytes)].

-Check Sum
The Check Sum is used to recognize transmission and synchronization faults. It is calculated from the arithmetical sum of the bytes from the control field to the last user data, without taking carry digits into account.

6.1.3.2 Communication process

The Data Link Layer uses two kinds of transmission services:

Send / Confirm	SND / CON
Request / Respond	REQ / RSP

After the reception of a correct telegram the meter waits maximum 80ms before answering. A received telegram is considered as correct if it passes the following tests:

- Start /Parity /Stop bits per character
- Start /Check Sum /Stop characters per telegram format
- The second Start character, the parity of the two field lengths, and the number of additional characters received (= L Field + 6) with a long frame

Send / Confirm Procedure
SND_NKE
This procedure serves to start up after the interruption or beginning of communication. If the meter was selected for secondary addressing, it will be deselected. The value of the frame count bit FCB is cleared in the meter, i.e. it expects that the first telegram from a master with FCV=1 contains a FCB=1. The meter either confirms a correct reception with the single character acknowledge (E5h) or omits the confirmation if it did not receive the telegram correctly.

SND_UD
This procedure is used to send user data to the meter. The meter either confirms a correct reception with the single character acknowledge (E5h) or omits the confirmation if it did not receive the telegram correctly.

Request / Respond Procedure
REQ_UD2 / RSP_UD
The master requests data from the meter using the REQ_UD2 telegram. The meter will either transfer its data with RSP_UD, or gives no response indicating that the request has not been received correctly or that the address does not match. The meter indicates to the master that there is more data in the next telegram by sending 1Fh as the last user data.

6.1.3.2.1 Selection and Secondary Addressing

It is possible to communicate with the meter using secondary addressing. The secondary addressing takes place with help of a selection:

68h	0Bh	0Bh	68h	53h	FDh	52h	ID1-4	Man 1-2	Gen	Med	CS	16h

Structure of a telegram for selecting a meter

The master sends a SND_UD with the control information 52h to the address 253 (FDh) and fills the specific meter secondary address (identification number, manufacturer, version and medium) with the values of the meter that is to be addressed. The address FDh and the control information 52h is the indication for the meter to compare the following secondary address with its own and to change into the selected state should it match. In this case the meter answers the selection with an acknowledgement (E5h), otherwise it doesn't reply. Selected state means that the meter can be addressed with the bus address 253 (FDh).

During selection individual positions of the secondary addresses can be occupied with wildcards. Such a wildcard means that this position will not be taken into account during selection. In the identification number each individual digit can be wild-carded by a wildcard nibble Fh while the fields for manufacturer, version and medium can be wild-carded by a wildcard byte FFh.

The meter will remain selected until it receives a selection command with non-matching secondary addresses, a selection command with CI=56h, or a SND_NKE to address 253.

6.1.4 TELEGRAMS

The communication can be divided in two parts. One part is reading data from the meter and the other part is sending data to it. This section describes typical telegrams sent to and received from the ODIN.

The data readout procedure starts when the master sends a REQ_UD2 telegram to the meter. The meter responds with a RSP_UD telegram. The last DIF in the user data part of the telegram is 0F to indicate that there are no more telegrams to read.

Using SND_UD telegrams data or commands can be sent to the meter. The following is possible to perform with SND_UD telegrams on the ODIN meter:

- Set primary address

6.1.4.1 Minimum time between requests

It may not be possible to read data from the meter too frequently. When the meter sends out data it uses power stored in a capacitor. If the voltage of the capacitor drops below a certain level the meter will stop sending out the telegram. If this happens it is recommended to make a small delay (approximately 1 second) to allow for the internal capacitor to be charged.

6.1.4.2 Read out telegram

Below is specified the telegram sent out by the ODIN meter at a normal read out, that is after the ODIN meter have received a request user data 2 command (REQ_UD2) *⁾

<table>
<tr><th>Byte No</th><th>Size (in bytes)</th><th>Value</th><th>Description</th><th>Explanation</th></tr>
<tr><td>1</td><td>1</td><td>68</td><td>Start character</td><td>[always same]</td></tr>
<tr><td>2</td><td>1</td><td>2D</td><td>L-field, calculated from C field to last user data</td><td>0x2D = 45 bytes (byte no 5 to 49)</td></tr>
<tr><td>3</td><td>1</td><td>2D</td><td>L-field, repeated</td><td>[same as above]</td></tr>
<tr><td>4</td><td>1</td><td>68</td><td>Start character</td><td>[always same]</td></tr>
<tr><td>5</td><td>1</td><td>08</td><td>C-field, RSP_UD</td><td>0000 1000
| | | | ++++- Function, 8 = User data
| | | +-------- DFC, 0 = can accept further data
| | +--------- ACD, 0 = class 2 data
| +---------- Direction, 0 = from meter
+------------- [always 0]</td></tr>
<tr><td>6</td><td>1</td><td>xx</td><td>A-field, address</td><td>Primary address 1-250, 0 = No primary address</td></tr>
<tr><td>7</td><td>1</td><td>72</td><td>CI-field, variable data respond, LSB first</td><td>0111 0010
++++ +|++- Variable data respond
+---- Mode 1 = LSB first</td></tr>
<tr><td>8-11</td><td>4</td><td>xxxxxxxx</td><td>Identification Number, 8 BCD digits</td><td>Serial number. LSB first, 12 34 56 78 sent as 78 56 34 12</td></tr>
<tr><td>12-13</td><td>2</td><td>4204</td><td>Manufacturer: ABB</td><td>ABB = 0442, LSB first gives 4204</td></tr>
<tr><td>14</td><td>1</td><td>07</td><td>Version</td><td>Protocol version, decided by ABB</td></tr>
<tr><td>15</td><td>1</td><td>02</td><td>Medium, 02 = Electricity</td><td>02 = electricity</td></tr>
<tr><td>16</td><td>1</td><td>xx</td><td>Number of accesses</td><td>Increased by 1 after every respond (RSP_UD)</td></tr>
<tr><td>17</td><td>1</td><td>xx</td><td>Status</td><td>00xx xxxx
| | | | | | | +- Application busy
| | | | | | +-- Any application error (application = internal)
| | | | | +---- Power low
| | | | +----- Permanent error
| | | +-------- Temporary error
| | +--------- Installation error (specific to manufacturer)
| +---------- Not used (specific to manufacturer)
+------------- Not used (specific to manufacturer)</td></tr>
<tr><td>18-19</td><td>2</td><td>0000</td><td>Signature (0000 = no encryption)</td><td>[always same]</td></tr>
<tr><td>20</td><td>1</td><td>0E</td><td>DIF size, 12 digit BCD</td><td>0000 1110
| | | | ++++- 12 digit BCD
| | ++-------- Instantaneous value
| +----------- LSB of storage number
+------------- No DIFE follows</td></tr>
<tr><td>21</td><td>1</td><td>84</td><td>VIF for units kWh with resolution 0,01kWh 2dec</td><td>1000 0100
| | | | |+++- 0b100 = 4, 10^(4-3) = 10 = 0.01k
|+++ +----- Unit is Wh
+------------- VIFE will follow</td></tr>
<tr><td>22</td><td>1</td><td>xx</td><td>VIFE, status</td><td>0xxx xxxx
|+++ ++++- Status code
+------------- No VIFE follows</td></tr>
<tr><td>23-28</td><td>6</td><td>xxxxxxxx xxxx</td><td>Active energy, Total</td><td>kWh with two decimals and LSB first</td></tr>
<tr><td>29</td><td>1</td><td>0B</td><td>DIF size, 6 digit BCD</td><td>0000 1011
| | | | ++++- 12 digit BCD
| | ++-------- Instantaneous value
| +----------- LSB of storage number
+------------- No DIFE follows</td></tr>
<tr><td>30-31</td><td>2</td><td>FF92</td><td>Transformer ratio</td><td>1111 1111
|+++ ++++- VIFE and data is manufacturer specific
+------------- VIFE will follow
1001 0010
|+++ ++++- Transformer ratio (decided by ABB)
+------------- VIFE will follow</td></tr>
<tr><td>32</td><td>1</td><td>xx</td><td>VIFE, status</td><td>0xxx xxxx
|+++ ++++- Status code
+------------- No VIFE follows</td></tr>
<tr><td>33-35</td><td>3</td><td>xxxxxx</td><td>Transformer ratio</td><td>Transformer ratio in BCD format with LSB first (status byte marked not active in direct connected meter)</td></tr>
</table>

Telegram continues on next page.

*⁾ Notice that the telegram structure may differ in different protocol versions. Any remote reading system should decode the telegram according to M-Bus standard, not according to the specific telegram stated here.

Telegram continued (all values are hexadecimal).

Byte No	Size (in bytes)	Value	Description	Explanation
36	1	0D	DIF size, variable length	0000 1101 | | | | ++++- Variable length | | ++-------- Instantaneous value | +----------- LSB of storage number +------------- No DIFE follows
37-38	2	FD8E	Firmware version	1111 1011 ++++ ++++- True VIF according to table $FD follows in VIFE 1000 1110 |+++ ++++- Firmware version +------------- VIFE will follow
39	1	xx	VIFE, status	0xxx xxxx |+++ ++++- Error code +------------- No VIFE follows
40	1	08	ASCII string, 8 characters	0000 1000 ++++ ++++- ASCII string, 8 characters
41-48	8	xxxxxxxx xxxxxxxx	Firmware version	Firmware version in ASCII format with LSB first in format "Oxxx-yyy" where xxx specifies the total firmware version and yyy the version of the basic metering part of the firmware
49	1	0F	DIF indicating that this is the last telegram	0000 1111 | | | | ++++- Special function | | | +-------- 0 = End of telegram +++--------- [always same]
50	1	xx	CS checksum, calculated from C field to last data	Checksum on byte number 5 to 69
51	1	16	Stop character	[always same]

6.1.4.3 Sending data to the meter

Below are described telegrams possible to send to the ODIN meter.

6.1.4.3.1 Set primary address

The primary address is set by sending the following command (all values are hexadecimal):

Byte No	Size (in bytes)	Value	Description	Explanation
1	1	68	Start character	[always same]
2	1	06	L-field, calculated from C field to last user data	No of bytes between byte no 5 and byte no 10
3	1	06	L-field, repeated	[same as above]
4	1	68	Start character	[always same]
5	1	53/73	C-field, SND_UD	01x1 0011 | | | | ++++- Function, 3 = Send user data | | | +------- FCV, 1 = FCB is valid | | +--------- FCB, Alternate for successive transfers | +----------- Direction, 1 = to meter +------------- [always 0]
6	1	xx	A-field, address	Primary address 1-250, 0 = No primary address
7	1	51	CI-field, data send, LSB first	0101 0001 ++++ +|++- Data send +---- Mode, 0 = Mode 1 (LSB first)
8	1	01	DIF size, 8 bit integer	0000 0001 | | | | ++++- 8 bit integer | | ++-------- Instantaneous value | +----------- LSB of storage number +------------- No DIFE follows
9	1	7A	VIF for bus address	0111 1010 |+++ ++++- Bus address +------------- No VIFE follows
10	1	xx	New primary address	New primary address, LSB first
11	1	xx	CS checksum, calculated from C field to last data	Checksum on bytes between byte no 5 and byte no 10
12	1	16	Stop character	[always same]

6.1.4.3.2 Communication settings

If communication with primary addressing is used the primary address is set via communication (see 6.1.4.3.1).

7 ACCESSORIES

Accessory	ABB part number	
Communication adapter for M-Bus	CTM04000	2CMA 137 090 R1000
Communication adapter for RS232	CRM04000	2CMA 137 091 R1000
Communication adapter for Ethernet	CEM05000	2CMA 137 099 R1000
Communication adapter for LON PLC, A-band	CAL06000	2CMA 137 100 R1000
Communication adapter for LON PLC, C-band	CCL06000	2CMA 137 103 R1000
Communication adapter for GSM/GPRS	CGM06000	2CMA 137 104 R1000
Communication adapter for EIB/KNX	ZS/S 1.1	2CDG 110 083 R0011
DIN-rail (for wall-mounting)		2CMA 132 540 R1000
Terminal cover for sealing		2CMA 131 026 R1000
Front mounting kit (for panel-mounting)		2CMA 132 635 R1000
Enclosure for wall mounting		2CMA 131 022 R1000

8 SERVICE AND MAINTENANCE

8.1 RECALIBRATION

It should not be necessary to recalibrate the meter during its lifetime as it is an electronic meter with no moving parts and electronics, voltage and current sensors that do not naturally degrade or change with time under specified environmental conditions. If degradation in the accuracy is observed the meter has probably been partly damaged (for example due to lightning strike or extreme environmental conditions etc) and should be sent for repair or exchanged.

8.2 CLEANING

If the meter is dirty and needs to be cleaned, use lightly moistened tissue with water based mild detergent. Make sure no liquid goes into the meter as this could damage the meter.