

# AMR & BILLING

Automatic Meter Reading  
Loss & Leakages  
Communication Equipments  
Meters



**CATALOG  
2011**

**AKTİF**  
MÜHENDİSLİK  
an Aktif Group Company



Aktif trade mark for Medium voltage switchgears, Switching equipment and Kiosks with high quality and environmentally sensitive



Aktif trade mark for Capacitor Banks, Harmonic Filters, Resistors, Medical Insulated Power Panels, Synchronization and Energy automation Panels with high quality and environmentally sensitive



Aktif trade mark for Measuring, Protection, Automatic Meter Reading, Billing and Energy Management Software.



Aktif trade mark for Measuring, Protection, Control and Power Quality products with high quality, long life and environmentally sensitive



Identifies the product as top quality, safe and one step forward of the similar ones.



Symbolizes measurable energy saving products helps to energy continuity.



Identifies smart control logic.



Identifies easy to use products, simplifies the difficult tasks.



Green products, respects to the nature and our future.

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# Company Profile



## Aktif Mühendislik Ltd.

Aktif Engineering (AMDT) is established in 1996 Measuring, Protecting and Quality of Electricity.

2200m2 headquarter of AMDT is located in Istanbul consisting of 35 employees. Since establishment AMDT provides high quality engineering, supplying and start-up services for the power quality, energy saving, energy metering, protection.

AMDT provides standard and custom designed solutions to domestic and international customers, with over 15 years of experience.

## Aktif Raylı Sistemler Ltd.

Aktif Railway Systems (ARS) is established in 2008 for the designing and providing of traction systems' substations as well as providing on-board equipment used on vehicles.

The main purpose of ARS is providing engineering services and products to public bodies and companies in this sector.

Even though it is a brand new company, ARS managed to complete successfully both Antalya Light Rail System project as well as Istanbul Metro Stinger System projects.



## Aksis Enerji Sistemleri Ltd.

Aksis Energy Metering Systems (AKS) is established in 2003 for providing metering solutions like Automatic Meter Reading, Billing Software in every level of energy sector. The company is focused on saving and efficient using of energy by its Meter Management and Loss & Leakage tracing solutions.

AKS answers all expectations in power systems with high quality products and custom design software solutions.

AKS customers create over 100 million Euro energy bills using different Metering, Management and Billing methods of AKS.

# Company Profile

## Aktif Elektroteknik A.Ş.

The company is established to manufacture Switchgears and Kiosks under the name of "Setas" in 1981. First in 2008, company merged to Aktif Group as Aktif Elektroteknik (AET) and then the company becomes international after significant participation of Italian Friem S.p.A in 2009.

9000m2 factory of AET is located in Ankara consisting of over 100 employees.

AET operates with its 30 years of manufacturing experience, modernized machinery line, ever increasing know-how, experienced Turkish and Italian R&D teams, quality products type tested by the leading accredited European laboratories and the vision of new ideas to meet with future expectations.



## Friem S.p.A.

Friem manufactured over 40 million ampere and 1000 power rectifiers for the worldwide since it's established in Milan at 1950.

Having technical knowledge of energy and electro mechanics along with ability of complete design of conversion systems, FRIEM provides also high voltage DC insulators, DC switches, anodic control and protection products and auxiliary equipments like polarization products to its customers.

Friem is a share holder of Aktif Elektronik in Turkey and also COET S.r.L in Italy.



## Coet S.r.L.

Since establishment in 1962 in Milan, COET has been producing AC/DC switching equipments and panels that are used safely by its customers thanks to the COET's work on industrial and electric equipment and patents obtained in this field.

All manufactured products are the result of long technical research and development work. This way, the company is known for the originality and diversity of its planned solutions.

COET has been working on Industrial and railway systems and has become one of the leading companies in the field of supplying switching equipments for traction substation.



# Company Profile

## Introduction

Aktif Group is in continuous development with its customer oriented activities, advanced engineering know-how, R&D works, software developing abilities and with the continuous support of loyal customers that are attained and protected by precise work and ethical principles of the company.

The group companies have ISO 9001 since 90s and our factory has ISO 14001 Environment and ISO 18001 Occupational Health and Safety Certificates.



## Technology

The most important activities of Aktif is R&D and increase the Employee quality which the investment amount of these activities are more than average.

All mechanical projects are designed by 3D-CAD platforms. Power flow, test and quality works are calculated by Worldwide accepted simulation software and ActWin software as well as developing software for different platforms.

In order to increase the production quality and capacity all machinery within the facility are renewed with latest technology equipment in 2009.

## Mission

By the help of our followings mission is continuing to announce product quality and knowledge of our company and country in best possible way by meeting rising customer expectations.

- ▶ open minded approach
- ▶ high quality policy
- ▶ innovative ideas
- ▶ constantly improved processes
- ▶ polished employees
- ▶ knowledge based decisions



## Vision

To increase the number of our loyal customers in global market, hence increasing the market share and becoming reputable, reliable and preferred company as worldwide with our;

prominent quality difference,  
customer oriented approach,  
innovative activities,  
open minded approach.

# Company Profile



## High Performance, Durable and Simple

Endurance of our products, which are produced with high level of awareness and accurateness in addition to follow international standards, ensures an outstanding performance for the users. Therefore our products are considered as top of the line products.

Visual simplicity and being user friendly are the design criteria for the software and hardware of our products. Our products have the most simple and functional features for emergency applications as well as persistence of habits and customer satisfaction are basics in design, production and shipment.



## Local & Remote Monitoring

Energy continuity and efficiency can be ensured only by monitoring of equipments local and remotely.

Our products are designed with remote monitoring and management features by the help of our software development abilities on different platforms and hardware capabilities. This will ensure the saving and profitability, directly.

## Security

The human safety and security are the main concerns in all of our products.

Design, Interlock logics and documentation of our products are implemented, manufactured and tested in order to reach the highest safety level.

Furthermore, services and site works are done according to human safety rules by taking into account the dangerous of electricity.



## Service Continuity

The service continuity means efficiency of power consequently profitability of the business.

Our products are designed and manufactured in order to ensure energy sustainability and provide the best service availability.

This policy is the cornerstone of our orientation and training programs and it is fully applied by our technical and administrative staff.



# AMR & Billing Software

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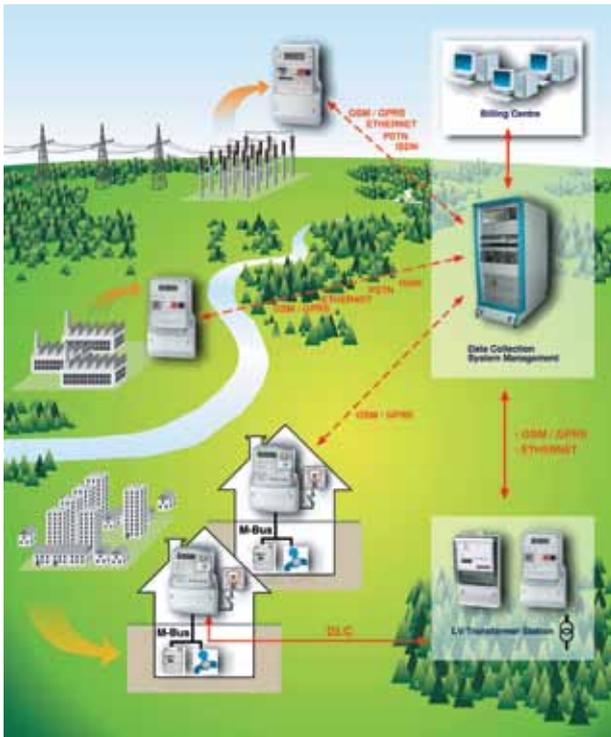


A

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AMR & Billing  
Software

# A | AMR & Billing Software



Automatic Meter Reading (AMR) is the technology of automatically gathering consumption, diagnostic, and status data from meters such as electricity meters, gas meters (also correctors) and water meters. The collected data transferred to a central database for billing, troubleshooting, and analyzing.

## Benefits

- ▶ Faster data readout
- ▶ Decrease in operating costs
- ▶ Accurate meter readout, so less invoice complaints
- ▶ Possibility to read meters regardless of environmental conditions like weather
- ▶ Ability to read hourly consumptions for large consumers
- ▶ Ability to use complex tariff rules
- ▶ Demand control
- ▶ On-demand meter readout
- ▶ Decrease in losses and detection of fraud

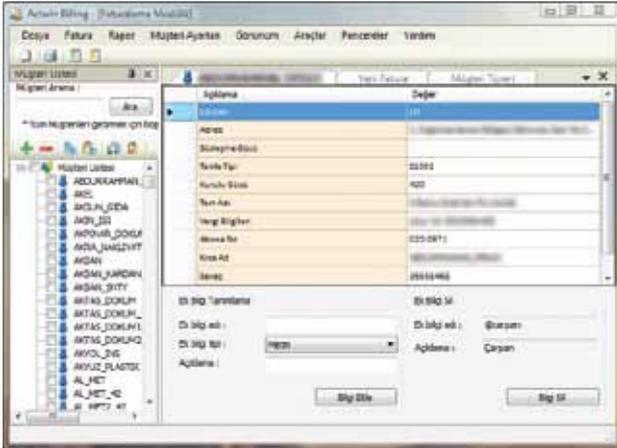


## A 1 Actwin Billing Software

“ActWin Billing” Energy Billing and Reporting software is developed for reading energy meters, creating invoices and generating reports from the created invoices and read data.

The software consists of three modules:

- ▶ Data Collection Module
- ▶ Invoice Generation Module
- ▶ Reporting Module



### A 1.1 Data Collection Module

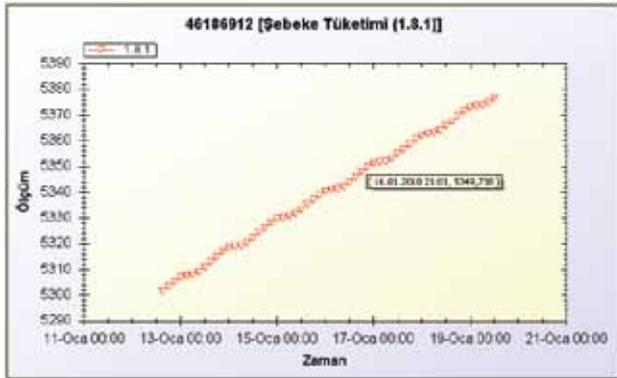
The “data collection module” as it is called, collects data from meters on the field. It is possible to communicate with IEC62056-21 (former IEC1107) and DLMS protocol through RS485, Ethernet, Fiber-Optics, GSM/GPRS and Radio Frequency (RF). Also it is possible to integrate with other communication interfaces like Zigbee, PSTN etc and protocols like Modbus.

The collected data may be stored in database servers like Microsoft SQL Server, Oracle or MySQL. Also other databases can be implemented on customer request.

With very small configuration it is possible to communicate with thousands of meters. The module automatically groups the devices according to their communication interfaces and read up to 50 devices at the same time without a problem. By this way the time elapsed to read all the meters decrease dramatically.

Main features of the module are:

- ▶ Supports IEC62056-21 (former IEC1107) and DLMS protocol (others can be implemented),
- ▶ Supports several interfaces like RS485, Ethernet, Fiber-Optics, GSM/GPRS, PSTN and RF,
- ▶ All collected data are stored in a database,
- ▶ Automatically performs parallel readout.



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46186912	1.8.1	30.01.2010 09:45:28	5336,710
46186912	1.8.1	30.01.2010 09:45:29	5336,710
46186912	1.8.1	30.01.2010 09:45:30	5336,710
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46186912	1.8.1	30.01.2010 09:45:34	5336,710
46186912	1.8.1	30.01.2010 09:45:35	5336,710
46186912	1.8.1	30.01.2010 09:45:36	5336,710
46186912	1.8.1	30.01.2010 09:45:37	5336,710
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46186912	1.8.1	30.01.2010 09:45:49	5336,710
46186912	1.8.1	30.01.2010 09:45:50	5336,710
46186912	1.8.1	30.01.2010 09:45:51	5336,710
46186912	1.8.1	30.01.2010 09:45:52	5336,710
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46186912	1.8.1	30.01.2010 09:45:57	5336,710
46186912	1.8.1	30.01.2010 09:45:58	5336,710
46186912	1.8.1	30.01.2010 09:45:59	5336,710
46186912	1.8.1	30.01.2010 09:46:00	5336,710

## A 1.2 Invoice Generation Module

The “invoice generation module” generates invoices and summary reports for all customers defined in the system. All invoice style (the template) and calculations in the invoices can be specialized according to customer needs.

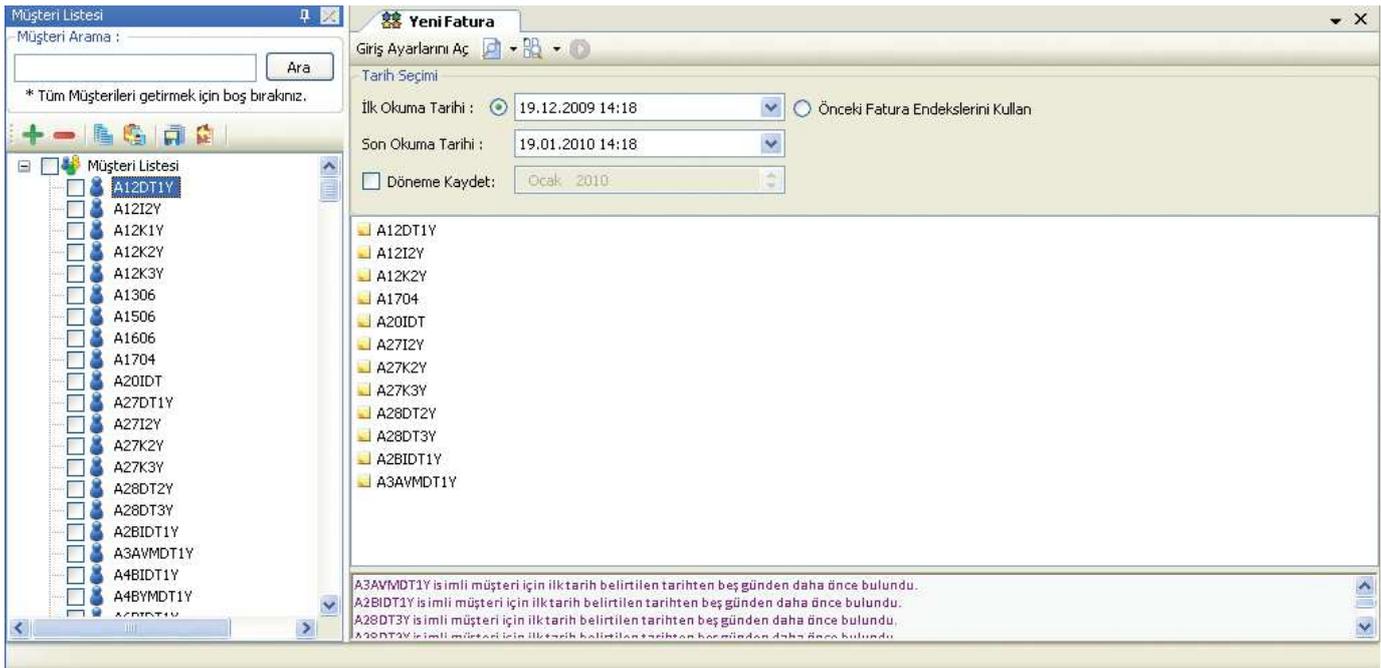
All customers may have limitless definition fields like customer number, customer address, tax information, and other definitions can be added by the software operator. The defined fields can be placed anywhere on the invoice template and calculations can be done according to these values.

It is possible to define countless tariff types like industry, residence, public places etc. Like these tariff may have different rates they may also have different calculation algorithms.

To create an invoice the list of customers and the time interval should be selected. After that with just one click all the invoices are created and saved. Printing is also very easy, just select the created invoice group and click print.

Main features of the module are:

- ▶ Automatic saving of the invoices to the corresponding invoice term,
- ▶ Automatic summary report generation,
- ▶ Fully customizable invoice design and calculation algorithm,
- ▶ Ability to print on desired paper size like A4, A5 and custom papers,
- ▶ Ability to exchange data with accounting department and banks through XML or web services.



### A 1.3 Reporting Module

Created invoices are automatically saved with the invoice generation module. By the help “reporting module” reports according to the customers and terms can be generated.

System operators can define their custom reports with the software. These custom reports may contain all the invoice parameters like energy consumptions, tariff rates, taxes and customer definitions like customer no, address. There is no limit on the reports created.

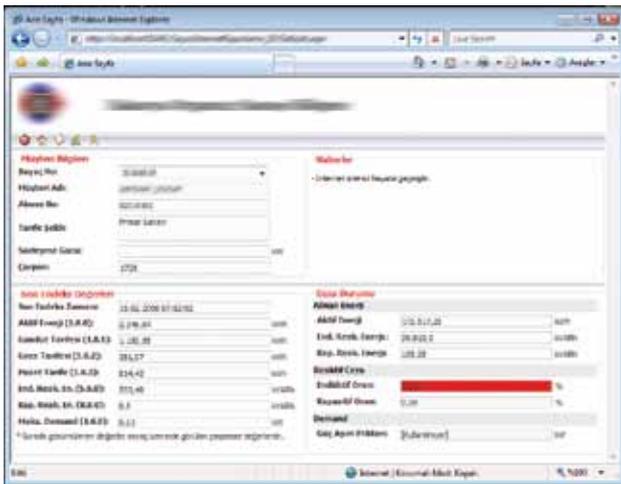
Mainly there are two report types; customer reports and term reports. The customer report shows the desired invoice terms values for a selected customer. For example a report for the ABC company with the Dec2009 and Jan2010 terms. The other report type, term report, shows values for a specified term with selected customers. For example Jan2010 report for ABC, DEF and GHI customers.

Main features of the module are:

- ▶ Possibility to generate unlimited number of report types,
- ▶ Filtering for invoice terms,
- ▶ Filtering for customers,
- ▶ Ability to export all generated reports to MS Excel.

Dönem Raporu							
Dönemler		Rapor					
2009 - 02		Rapor					
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▶	23.01.2009	1119,2	0	1	1119,2	0	10
	23.01.2009	4075,6	0	1	4075,6	0	10
	23.01.2009	39,546	0	50	1977,3	0	10
	23.01.2009	1182,1	0	1	1182,1	0	10
	23.01.2009	5464,6	0	1	5464,6	0	10
	23.01.2009	41,9	0	1	41,9	0	10
	23.01.2009	338,9	0	1	338,9	0	10
	23.01.2009	136,5	0	1	136,5	0	10
	23.01.2009	280,9	0	1	280,9	0	10
	23.01.2009	1764,7	0	1	1764,7	0	10
	23.01.2009	491,582	0	30	14747,46	0	10
	23.01.2009	494,2	0	1	494,2	0	10
	23.01.2009	1,522	0	50	76,1	0	10
	23.01.2009	58,918	0	30	1767,54	0	10
	23.01.2009	66,367	0	40	2654,68	0	10

## A 2 Internet Interface



In an AMR system, customers should be able to monitor and by this way control their consumptions daily. With the internet interface, the AMR system can be monitored with some limitations through a web browser like Internet Explorer.

Accessing the system through Internet is protected in several levels. The first protection is on the main page, users should provide the identification number and the associated password in order to enter the system. Other protections are web based protection provided by .NET framework and SQL protection provided by MSSQL.

With the help of the interface customers may monitor their current meter values and check if the data will cause and penalty like reactive energy penalty or demand exceeding penalty.

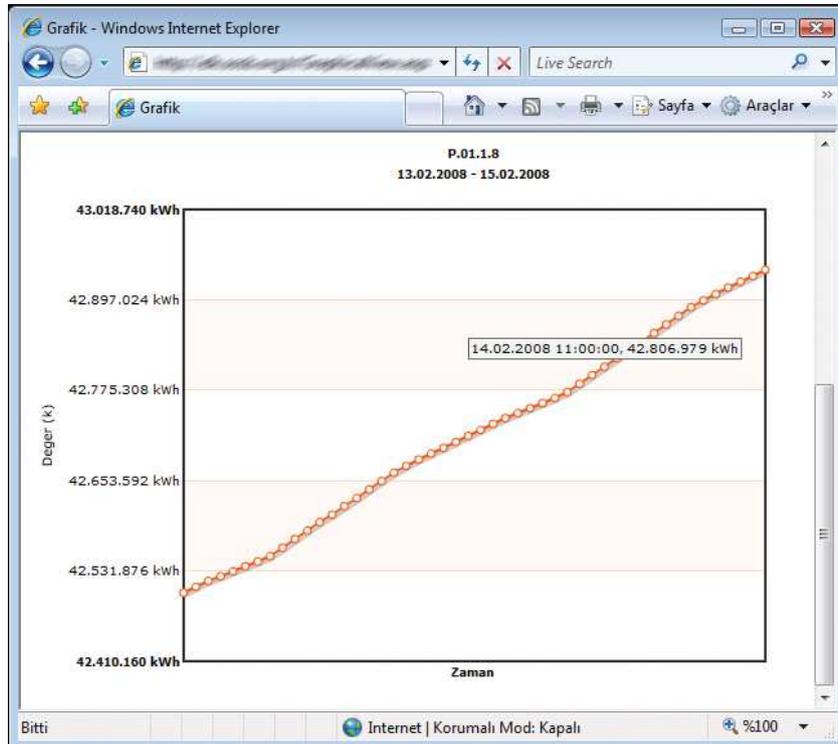
Also it is possible to list the desired values like consumptions, voltages and harmonics in a table. The time interval of the list can be defined by the customer himself. The table values can be exported to MS Excel and MS Word with special formatting.



Bar charts for energy types (active energy, inductive reactive energy, capacitive reactive energy) or energy tariffs can be drawn to see the system characteristics in time. The time axis interval for bar charts is months, and the months to display can be configured by the system operator.

Besides the bar charts, users may see the trends with line chart. All the data that is collected with AMR system can be drawn on this chart type, but system operator can select the data to be shown on Internet interface. The interval may be selected by the user with two calendars.

- ▶ Momentary values on meters can be monitored,
- ▶ Customers tariff type and demand power is displayed,
- ▶ If applicable, reactive energy penalties can be shown with highlighted colors,
- ▶ If applicable, demand exceed penalties can be shown with highlighted colors,
- ▶ Ability to show data in desired time intervals, and exporting to MS Excel and MS Word,
- ▶ Ability to draw comparing consumption charts and trend charts,
- ▶ All charts are interactive charts, values are display with mouse movement,



## A 3 Integration

AMR systems aren't stand alone systems; they have to integrate with other systems like accounting, customer relations and even with banks.

Job of AMR system is to read data from meters and create reports, invoices from these data. To create an invoice the system should be interconnected to accounting departments or banks because it has to know if there are some late fees etc. Likewise, accounting departments should now the bill of each customer.

Also AMR system should be able get customer's data from some customer relations infrastructure like GPS location, customer number etc. So, these systems should be interconnected also.

In Summary, an AMR system should be able to communicate with other systems. Our AMR system's reports and invoices can create XML files, a global standard for exchanging information, and also connect to web services. In addition, custom solutions for any application can be developed.



## A 4 Prepayment

Normally customers pay for the energy consumed during the last billing period. This method is called post-payment because they pay after they consumed energy. Another way of collecting money is prepayment method. In this case, first customers buy energy and then consume it.

The obsolete way of prepayment metering was done by cards. For example, customers buy a card for 100 kWh and insert this card to the meter. After inserting it the credit is transferred to the meter and meters allow energy flow until the credit finishes. Later, the customers should buy another card or refill the existing one.

As you may see the procedure of refilling the meter with credit takes very long time and effort. New prepayment method overcame this by transferring the credit from a communication line like RS485, Ethernet, GPRS or RF.

The new prepayment meters have their own circuit breakers inside for cutting off energy when the credit finishes, so no other circuit breaker is required.

### Benefits Of New Prepayment system

- ▶ No Card is required
- ▶ Customers don't need to go to the billing station for buying credit. Credit is transferred through communication line
- ▶ Ability to see the left credit from Internet
- ▶ Ability to buy credits online with credit cards
- ▶ On Demand energy cut-off



# Losses & Fraud

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B

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B

Losses &  
Fraud

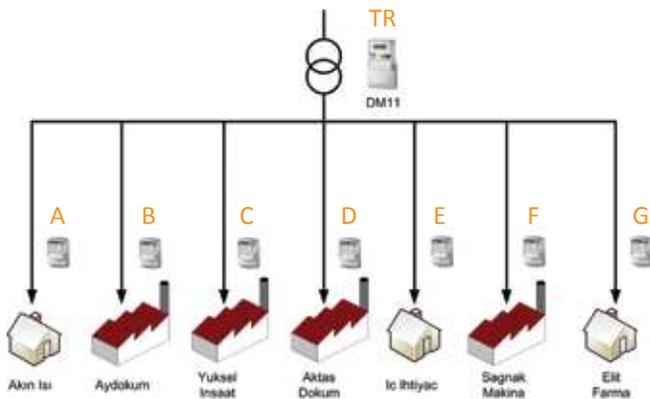
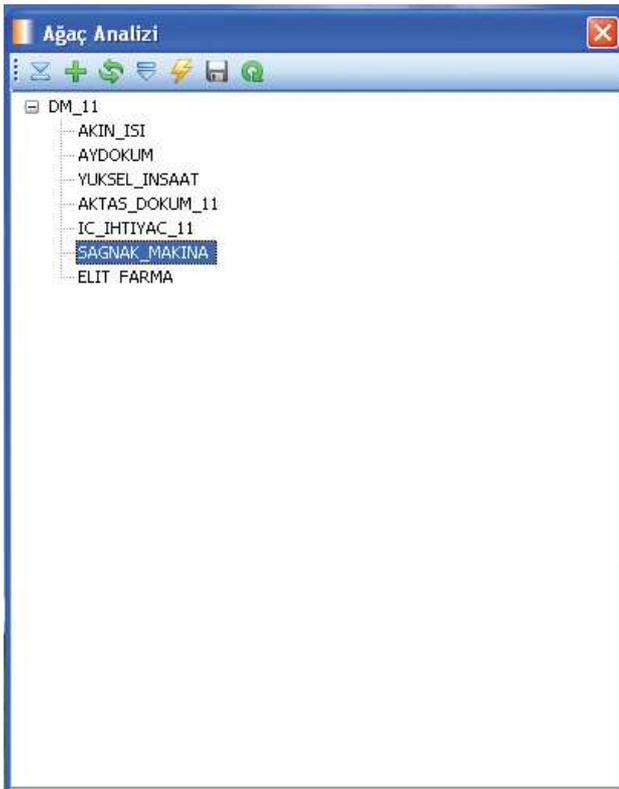
## B 1 Description and Importance

An electricity network is never works with 100% efficiency, there will be always some losses and frauds. Although, sometimes these losses percentage seems small their cost to the utility is always huge. For example, the total percentage of it in USA in 1998 is estimated between 0.5% and 3.5%. At the same year the total electricity bill was around 280 billion dollars. So, with the best estimation 1,4 billion dollar is lost and if we estimate with the worst case it will be around 10 billion dollars.

The only way to cope with this is AMR systems. Actually these systems become AMM (Advanced Metering Management) or AMI (Advanced Metering Infrastructure) systems because in addition to meter readout there are some advanced analyses and controls.

So, how do these systems decreases losses and fraud?

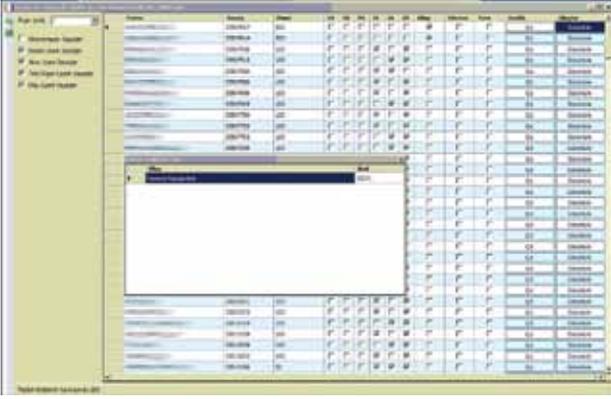
- ▶ Meters detect tampers and report these to the central station with call back functions.
- ▶ The system generates a grid that will point the possible location of losses.
- ▶ More accurate demand estimations with continuous data readout.
- ▶ Detection of abnormally low voltages, currents to catch defected transformers.
- ▶ Detection of abnormal phase angles for wrong connections to the meters.
- ▶ Comparing consumptions with previous seasons.



$$\text{Losses \& Fraud} = TR - (A+B+C+D+E+F+G)$$



## B 2 ActWin KKT Software



ActWin KKT software is designed to monitor and detect the losses and frauds in an AMM system. The software is integration to additional AMR software like Actwin Billing that collects continuous data from the electricity meters.

The software checks the network in some predefined time intervals and generates reports. These reports can be saved for later analyzing.

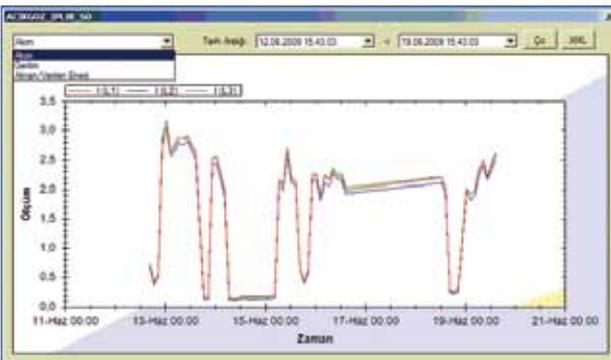
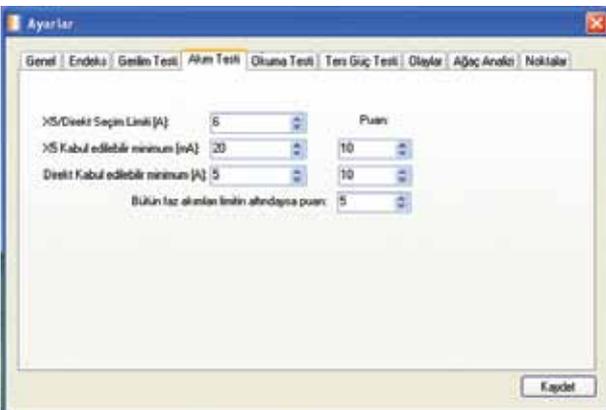
It has a unique point based system. Every situation has its own penalty point, for example, voltage unbalance is 10 points while terminal cover opening event is 200. The more points means the more risk of loss or fraud. The points per situation can be changed by the system operator.

On the report it is possible to see the trend chart by clicking the draw button. There are three charts that users may draw current, voltage and energy flow charts.

Another analyzes of the software is the tree analyzes. To make this analyzes meters should have collector meters in substations. In normal condition the consumption of collector meter should be around to the sum of all other meters.

When there is an unexpected difference between the consumptions, the systems warns the operator by highlighting the collector meter. Also it shows the percentage of difference.

The limits for unexpected difference and transformer and line losses can be defined by the operator to make better estimations.



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C

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Communication



## C 1 RS485 Serial Communication

### C 1.1 Copper Cable

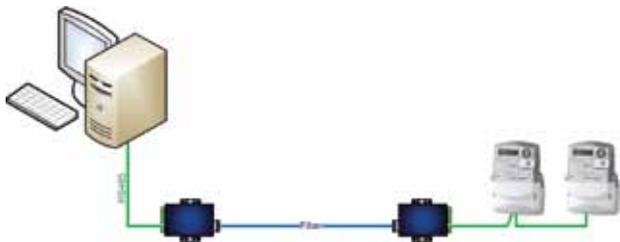
Generally RS485 physical communication method is used in AMR systems for shopping malls, factories and some residences because of its simplicity and coverage area. The communication is in master/slave topology, there might be several slaves but there must be a single master device. In general the master device asks to the slaves and the corresponding slave device responds.

Limitations and Advantages:

- ▶ Maximum 1200m in a single communication line.
- ▶ Maximum 32 devices in a single communication line. Number can be increased with repeaters up to 247.
- ▶ Easy to establish.
- ▶ Stable

Applications:

- ▶ Shopping malls
- ▶ Residences, Smart Buildings
- ▶ Factories



### C 1.2 Fiber-Optic Cable

Instead of copper wires fiber-optic cables can be used to transmit the data. To do that an RS485/Fiber-Optics converter should be used. This converter will convert the voltages to light pulses.

This conversion is used to overcome the distance limit. With fiber-optic cables it is possible to communicate up to 40 km in single mode fiber optic cable without using repeater. Today new projects needs hybrid fiber optic cable consist of the combination multi mode and single mode. Such infrastructure allows to communicate with AMR and other systems over same cable which are like SCADA, CCTV, Signalisation, protection etc.

Limitations and Advantages:

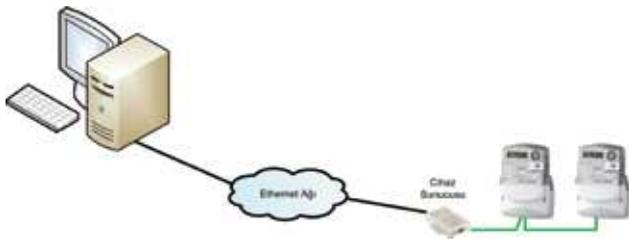
- ▶ Maximum 40 km in a single communication line.
- ▶ Maximum 32 devices in a single communication line. Number can be increased with repeaters up to 247.
- ▶ Expensive cables and labour cost.
- ▶ Ability communicate at very high speeds (Around 1 Tbps)

Applications:

- ▶ Industrial Zones (Communication between Substations)

## C 2 Ethernet Communication

### C 2.1 Copper Cable



Ethernet communication is specially designed for computer networks but current it is used for many other devices and meters are just one of them. In most cases Ethernet is used to decrease the cost of cables for RS485 communication, and used as a serial communication with master/slave topology.

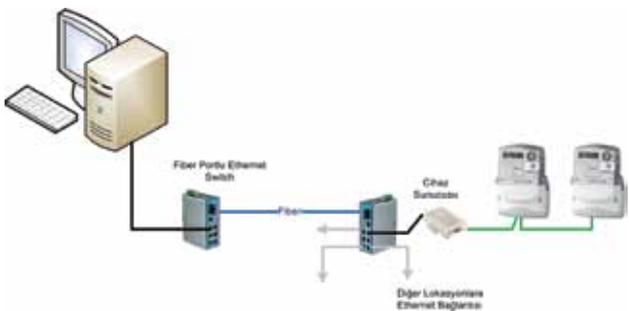
Limitations and Advantages:

- ▶ Maximum 100m cable length (without repeating devices)
- ▶ Because most meters have RS485 ports an Ethernet/RS485 is required.

Applications:

- ▶ Residences, Smart Buildings

### C 2.2 Fiber-Optic Cable



Some Ethernet switches especially the manageable ones may have fiber-optics ports instead of standard RJ45 ports. By this way it is possible to carry the Ethernet network up to 40km.

Limitations and Advantages:

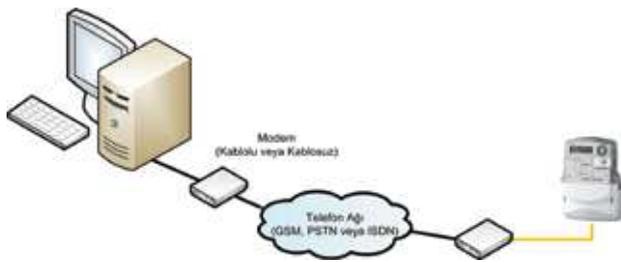
- ▶ Maximum 40 km in a single communication line.
- ▶ Expensive cables and switches

Applications:

- ▶ Industrial Zones (Communication between Substations)
- ▶ Utilities (Using High Voltage Line - OPGW)

## C 3 GSM, PSTN and ISDN Communication

GSM (Global Systems for Mobile Communications) is a cellular wireless network which mostly operates in frequencies 850MHz, 900MHz, 1800MHz and 1900MHz. The PSTN (Public Switched Telephone Network) is a wired telephone network that covers almost all the world like in your houses and ISDN is a smart networking technology that adds news services like video, data and other network services to regular PSTN.



Both systems are public systems so there is no need to establish extra communication network like in serial communication. But because they are public, the communication that uses them will have a communication cost. It is like calling someone and communicating.

Limitations and Advantages:

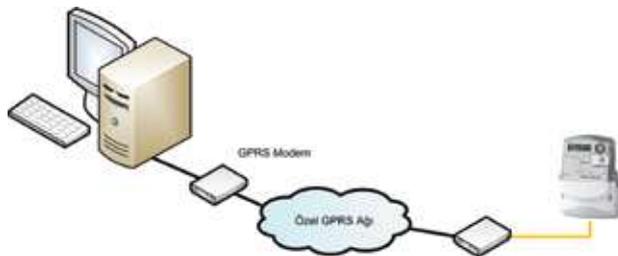
- ▶ No distance limit
- ▶ Has communication cost- depending on GSM Provider Company
- ▶ Limited to Low Communication Speed

Applications:

- ▶ AMR systems for cities and countries

## C 4 GPRS, EDGE Communication

GPRS is an extension to GSM technology. In GPRS first the data is packed and then transmitted like in regular GSM network. Because the data is packed it will consist of several packages, all these packages are re-joined at the destination.



GPRS has a communication cost but it is rather cheap than GSM or PSTN. Another advantage of GPRS is the pricing style. On GSM the time that connection is opened is billed but on GPRS communication only the data that is transmitted is billed. Because AMR data packages are very small (around 30 kB), it is a cost-effective solution.

Limitations and Advantages:

- ▶ No distance limit
- ▶ Cheaper communication when compared to GSM
- ▶ No regular maintenance requirement
- ▶ Direct access to meter

Applications:

- ▶ Industrial Zones
- ▶ Cities
- ▶ Countries

## C 5 PLC (Power Line Carrier) Communication

PLC (Power Line Carrier), is the system which data is transmitted through the power transmission cables. In 1950's, first it is tried to be used to change tariffs. In these attempts, a frequency between 100Hz and 3000Hz is used but because the quality of power lines is very poor the system didn't work stable.

In the beginning one way communication is used especially in street lightening automation and tariff changeover. In 1980's the communication speed reached up to 500kHz, and in 1990's two way communication was established.

Currently PLC communication can be used in systems where high communication speed is required like Internet but there are still problems with the quality of power lines.

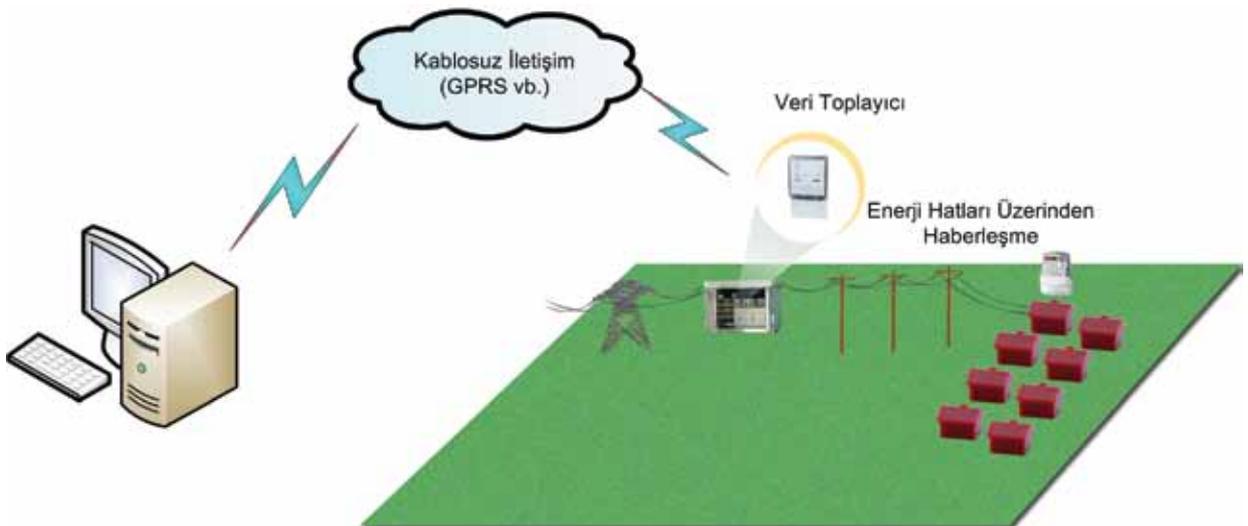
Although it communicates through power lines, the communication signals cannot pass distribution transformers. Because of that some data concentrators should be used in every distribution centre. The data that is collected with these concentrators should be transferred to AMR central station with one of the other communication interfaces like GPRS, GSM.

Limitations and Advantages:

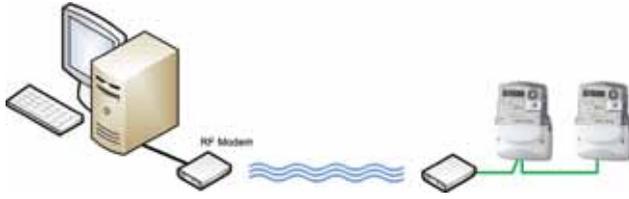
- ▶ No new communication infrastructure
- ▶ Distance is limited by the nature of communication method
- ▶ Concentrators are needed for each distribution transformer
- ▶ Concentrators must be connected to AMR central with other communication interfaces
- ▶ Prone to disturbances (caused by power lines or connected instruments)
- ▶ Hard to direct access to meter
- ▶ Maintenance can be costly in case frequent problems occurs

Applications:

- ▶ Cities
- ▶ Countries



## C 6 Wireless (Radio Frequency and Zigbee)



Radio frequency (RF) communication is very old communication type; the first data transmission was in 1866. Although it is very old, today it is used commonly in different automation types and one of them is AMR.

In RF, as the frequency increases the data rate increases so it can be very fast and the distance is increased when the transmitter power is increased. So, it seems to have both high speeds and long distances but there are some obstacles like licensing. In most countries above 5 W output power requires some licenses, so it is not preferred.

The main disadvantage of RF communication is its proneness to geographical conditions. To make a RF system work flawless a flat land is required, any hill or building will directly affect the distance covered.

Zigbee is a radio frequency communication type based on the IEEE 802.15.4 standard. The aim of Zigbee is low data rate, secure data transmission and low power which mean long battery life. The network that is established is a mesh network, which means every device in the network could operate as an independent router. The advantage of mesh network is backup capability by allowing reconfiguration around broken links.

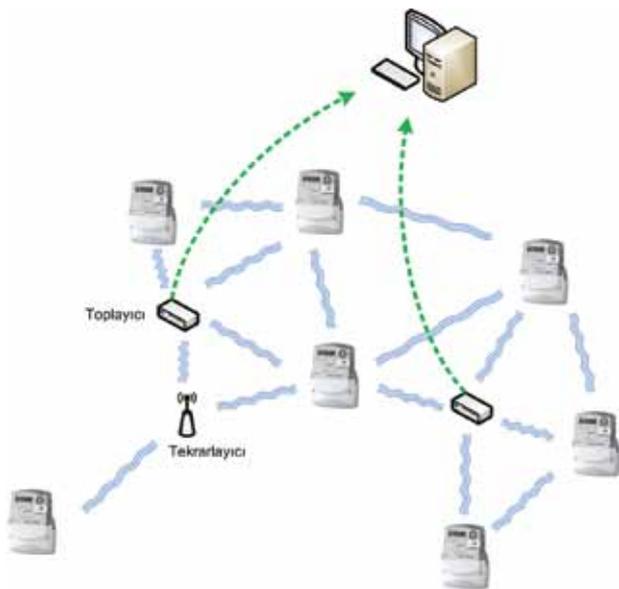
The AMR system that is established by Zigbee is called “Zigbee Smart Energy”. The system is named by the Zigbee Alliance. It is an association of companies working together to enable the Zigbee communication and products on an open global standard.

Limitations and Advantages:

- ▶ Coverage area can be increased with repeaters
- ▶ Effected from geography
- ▶ Strong backup of communication (for Zigbee)
- ▶ Maintenance fee may be costly

Applications:

- ▶ Campus
- ▶ Cities
- ▶ Countries

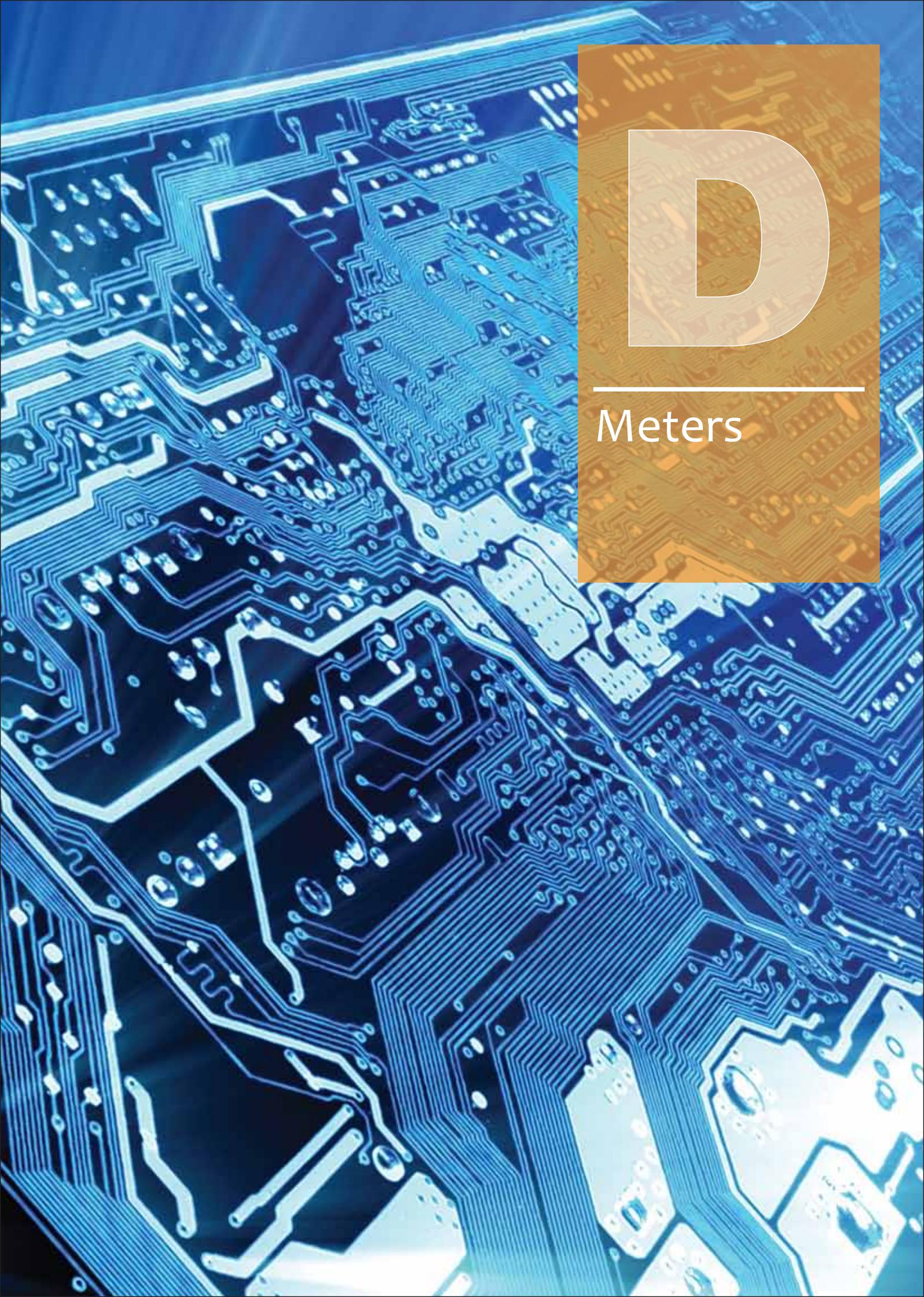


# Meters



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D

Meters

## D 1 Electricity Meters



Electricity meters are meters that measure the electrical energy supplied or produced. Typical household meters measure mainly the active energy but actually there is a lot of that an electricity meter can measure.

Like every other subject, users need to make the meter manufacturers develop advanced meters:

- ▶ Reactive energy is a useless energy but because it flows through the power lines it has some negative effects on the design of the power grid. So, distribution companies don't want their customers to use reactive energy. They control the reactive energy flow by billing it and for the bill meters should be able to measure the reactive energy.
- ▶ Electrical energy storage is an expensive work and when the energy level goes up it is impossible. Because of that energy producers want consumers to avoid peaks. To know the peaks the meters should measure the power, thus the demand.
- ▶ Some customers started to produce their own energy and even some started to sell this produced energy to the grid. Regular meters cannot measure the negative energy flow, so these meters should measure the opposite energy flow as well.
- ▶ By measuring the demand energy producers limited the consumption but still they need to estimate the future energy consumption. To make these estimations they need to monitor meters continuously and store statistical data in a database. So, meters should have some communication interface.
- ▶ For loss detection meters should check the phase sequence and should measure voltage, current and phase angles (wrong phase connection).
- ▶ For fraud detection meters should detect if there is a tamper to the devices.

There are a lot of other features like tariff, accuracy that are not mentioned here.



Typically digital electricity meters have an optical port for setting and simple reading purpose additionally they have RS485 or RS232 port which is enough for adapting to an AMR system because those are easily converted to other communication types.

#### Categorization of Electricity Meters

Connection Type	CT, VT Operated Meters - High Voltage CT Operated Meters - Low Voltage Direct Connected Three Phase Meters - Low Voltage Direct Connected Single Phase Meters - Low Voltage
Measurement Needs	Residential Meters (Measures only active energy) Industrial C&I Meters (Measures active, reactive energy, demand, voltage, current etc.) Grid Meters
Billing Types	Postpaid Meters Prepaid Meters
Accuracy (lower class means higher precision)	Class 0.2S (IEC 62053-22) Class 0.5S (IEC 62053-22) Class 1 (IEC 62053-21) Class 2 (IEC 62053-23) Class 3 (IEC 62053-23)
Communication	With Remote Communication output Included Remote Communication Without Remote Communication output
Mounting	Surface mounted Panel Mounted DIN Rail mounted

## D 2 Gas Meters

Gas meters are as it is called used to measure the gas flow through a pipe. Mostly the measured gas is natural gas and propane.

Gas metering is very difficult because the volume is affected from temperature and pressure. Because of that some compensation devices called volume correctors are used.



### Types of Gas Meters

- ▶ Diaphragm Meters
- ▶ Rotary Meters
- ▶ Turbine Meters
- ▶ Orifice Meters
- ▶ Ultrasonic Meters
- ▶ Coriolis Meters

In AMR system if directly the gas meter will be read (without corrector), usually the volume data is collected with a pulse collector. Collector device read these data and stores the values in its database. On predefined time interval it is either read by the AMR software or it directly sends the data (for example with SMS).

If gas volume is corrected with a corrector device than the corrector device is read. Most correctors have RS485 port that communicates with Modbus-RTU or IEC62056-21. With just a regular convertor this serial signal can be converted to any communication signal like GPRS.

### D 3 Water Meters

A water meter is used to monitor the volume of water flow. There are types like hot and cold water meters but the purpose and principle is the same. The only difference is, in hot water meters materials are manufactured to withstand higher temperatures.



#### Types of Water Meters

- ▶ Multi-jet Meters
- ▶ Single-jet Meters
- ▶ PD Meters
- ▶ Compound Meters
- ▶ Turbine Meters
- ▶ Fire Meters
- ▶ Mag Meters
- ▶ Ultrasonic Meters

Most water meters that are compatible with AMR systems have pulse outputs or pulse output modules can be mounted later. In most cases there is no electrical power source near water meters so communication is a problem for water meters. The pulse collector devices should be able to count impulses with dry contact and must work with an internal battery that will last for a long time.

The preferred communication for water meter collectors is SMS because the power consumed is very low which increases the battery life.

In another communication style, meters are equipped with RF modules with very low output power (to increase the battery life). This can be used if there is a RF receiver near the meter. Because of the harsh environment of water meters, water meters are very well protected. Likewise the collector devices should be protected well (at least IP54).





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