

## AMR Gas Meters System by Radio - A New Trend in Natural Gas Metering Technology in Romania

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**Abstract** – Natural gas is a non-regenerable energy source. For this motive it must be managed properly to protect it for future generation. Proper management of natural gas reserves requires submetering. Submetering of natural gas consumption and revenue collection is traditionally accomplished using diaphragm gas meter. To resolve some problem of revenue collection new technologies liken automatic meter reading is implemented. In this context we at AEM Luxten Lighting Co produce a radio module for automatic gas meters reading and the reading system for this gas meters.

**Keywords:** flowmeters, diaphragm gas meter, natural gas submetering, radio module for gas meters reading

### I. INTRODUCTION

Revenue collection is one of the core activities of any utility inclusive natural gas distribution company. This has traditionally been accomplished using conventional credit meters like diaphragm gas meter, with regular meter reading, extension of credit to customers and normal credit collection mechanisms.

This process is costly, with numerous inherent problems for both utility and customers. To solve some of these problems new technologies like automatic meter reading (AMR) [1-4] is implemented which offer benefits to both parties.

AMR was first tested 45 years ago when trials were conducted by AT & T in cooperation with a group of utilities and Westinghouse. After those successful experiments AT & T offered to provide phone system-based AMR services at \$ 2 per meter. The price was four times more than the monthly cost of a person to read the meter-50 cents. Thus the program was considered economically unfeasible.

The modern era of AMR began in 1985, when several major full-scale projects were implemented. AMR systems have been available to the utility industry for more than 20 years. However few natural gas utilities [1, 4] have chosen to implemented large scale AMR systems to replace manual meter reading. Despite the fact that AMR does not fundamental change the traditional way of collecting it does open up a communications channel between the utility and the consumer.

### II. THE LEVELS OF AMR METERING SYSTEM

AMR systems operate on three levels [1]. At the lowest level are the mechanical gas meters with pulse output and an interface module, which allows data to be transmitted from this remote device to a central location. These meters are installed at the consumer's home. In many instances this communication interface is bidirectional and allows central office signal to be received by the remote unit as well. The next level is the communications systems used for the transmission or telemetry of data and control send signals between the meter interface units and the central office. At the top level is the central office system equipment including receivers, data concentrators, controllers, host upload links and host or central computer with the data base for the collection of the metered gas consumption.

#### 2.1. Mechanical gas meter with pulse output

These are volumetric dry, diaphragms gas meters [5-6] meant for measuring domestic natural gases consumption. They have internal chambers with rubber walls that alternately fill and empty with the flowing gas. The mechanical motion thus generated is linked to a gear mechanism that moves the dials on the meter index (display) showing the volume of gas that has passed through the meter. Instantaneous flow rate is typically not measured. The diaphragm dry gas meters comply with OIML R6, R31 and to SR 6681-98 provisions. Some technical characteristics are presented in Table 1.

Table 1 [11 a]

	G 1,6	G 2,5	G 4
Cyclic volume V (dm <sup>3</sup> )	1,2	1,2	1,2
Maximum flow Q <sub>max</sub> (m <sup>3</sup> /h)	2,5	4	6
Minimum flow Q <sub>min</sub> (m <sup>3</sup> /h)	0,016	0,025	0,040
Maximum pressure P <sub>m</sub> (bar)	0,5		
Environmental and gas temperature range	- 20 ... +50 ° C		
One pulse value (on request)	0,002 m <sup>3</sup>		
Counter range	99999,999		

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Connections	G1 or G1 1/4"
Maximum admissible errors	± 3% for $Q_{min} \leq Q < Q_{max}$ ± 1,5% for $0,1 Q_{min} \leq Q \leq Q_{max}$
Weight (kg)	2,5
Overall dimensions (mm)	243 × 228 × 172

Their cases are cupped steel bodies with electrostatic spray paint with epoxipolyesteric powder. The rotation of gear is transferred via a magnetic coupling.

The gas meter with pulse output converts the data obtained from mechanical meter into an electrical signal by means of a reed switch group that is activated by a permanent magnet. It makes a sensitive reading and gives 2 pulses per one liter.

## 2.2. Interface module

Volumetric dry, diaphragms gas meters with pulse output has an interface module with power supply, meter sensors, controlling electronics and a communications interface that allows data to be transmitted from this remote device to a central location. In many instances this communication interface is bi-directional and allows central office signals to be received by the remote unit as well.

Every gas meter must have such interface unit to be remotely read.

The AMR system starts at the meter. Some means of translating reading from rotating meter dials into digital form is necessary in order to send digital metering data from the customer site to a central point.

## 2.3. Communications systems

Communications systems are used for the transmission or telemetry of data and control send signals between the meter interface units and the central office. Typically such communications take the form of telephone [1, 7-9], powerline carrier (PLC) [1,10], radiofrequency (RF) [1, 11b-11c , 12], or cable television [1]. The system components in the communications systems depend on the communication media used.

Radio is used in 90 % of the AMR meters installed around the world, making reading meters by radio the fastest growing segment of the AMR industry. It involves retrofitting an existing mechanical gas meter with pulse output with a radio AMR module [11b] that contains a radio transmitter and some times also a radio receiver. AMR modules work by sensing the mechanical motion that drives the mechanical register.

Radio AMR meter modules operate by transmitting periodically, or by responding to a radio interrogation. Periodic transmitting relies on either a fixed receiver being present nearby, or a mobile radio

in a handled computer or mounted in a vehicle coming with range when meter data is required.

The operation of radio AMR meter modules falls within the regulatory agencies of each country. These regulations determine the radio frequency, the transmission power levels and other technical characteristics (see table 2) of radio operation [11c].

Table 2 [11 b]

Communication channel frequency: 868 MHz;  
Modulation: RF-FSK;  
Radiated power: max. 3mW (5dBm);  
Transmission mode: bi-directional communication;  
The communication protocol: M-bus;  
The communication distance in open field: up to 200 m;  
Supply: Li battery - 3.6V (10 years life-time);  
Protection degree: IP 54;  
Operating temperature: -40 C...+60 C;  
Standards: according to R&TTE Directive;

The radio module for gas meters reading (see fig.1) is an instrument intended for the remote reading of the consumption recorded by a gas meter.

The module attached to gas meter meters pulses whose number is proportional to the gas volume measured by the meter. At the receipt of a radio message following a reading request, the module transmits by radio the value of the pulse counters.

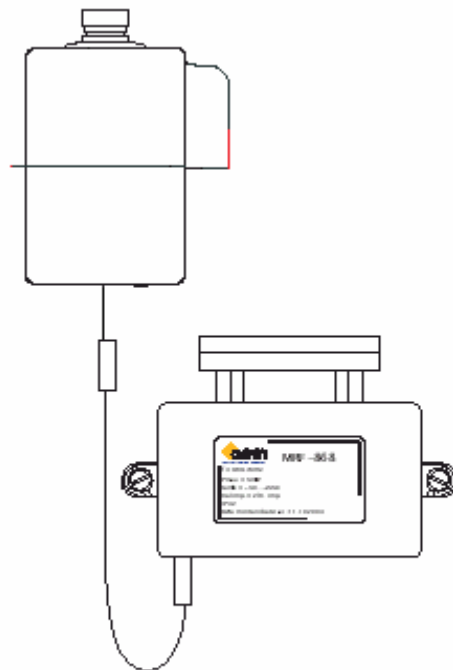


Fig. 1 Radio module for gas meter reading

The radio module is made up of the following:

- a pulse generator which takes over the pulses from the gas meter (the pulse has the weight of a certain gas volume);

- the printed board which contains a microcontroller with metering and communication functions, the radio circuit and the
- radio aerial;
- the battery for the electronic circuits supply;
- the case fixed on the gas meter, which contains the printed board and the battery.

#### 2.4. Central office systems equipment

At the top level is the central office system equipment including receivers, data concentrators, controllers, host upload links and host or central computer.

There are three major building block functions that the meter interface and related electronics must perform.

First, an electro-optical interface according to EN61107 (IEC 62056-21); must be incorporated into or attached to the meter. This converts informations conveyed by the meter's mechanical register indexes, into electronic signals which may be processed, manipulated, stored and transmitted.

The second functional building block is a controller unit consisting of a low-voltage power supply, signal processing electronics, microcomputer, random access memory and program memory used to store the real-time run or operating system program. The controller unit is used to process the signal originating from the meter's electro-optical interface devices. In effect, the controller unit converts the meter's electromechanical interface device signals into computer type converts key pad entries into numbers appearing on the display. The controller's RAM memory maintains an up-to-the-minute mirror image of the meter's dials and as the dials increment, so do the numerical representations stored in RAM.

The third functional building block is the communication scheme and its associated electronics transmit/receive electronics.

### III. REMOTE READING SYSTEM

Reading system is intended for the remote data collection concerning the consumption registered by gas meters equipped with radio module.

The system is made up of the following:

- gas meter equipped with radio module for remote reading (see pct. 2.1 - 2.3);
- PSIONWorkabout hand-held terminal equipped with radio interface;
- central computer with the database for the collection of the metered gas consumption (see pct 2.4).

On site data collection concerning gas consumption is carried out by means of PSION hand-held terminal provided with radio communication interface, and data storage is achieved on a PC. For these functions carrying out GazRadio\_PSION software application is used. This application is made up of two modules:

- GazMP, for hand-held terminals of PsionWorkabout type and

- Gaz MBD, for Purchase.

The GazMP module communicates with the gas meter through RS232 serial interface of Psion Workabout hand-held terminal by means of the radio module, and the communication with the PC is made by means of a RS232 cable. The application user interface is represented by a menus and dialog boxes system. The application starts working only after entering the user password. After the password checking, the user can use a menu comprising the following:

- configuration operations in the communication mode,
- addresses list loading,
- operations of current data reading and
- operations of current data transfer on a PC.

The configuration operations in the communication mode consist of the following:

- a) Communication mode,

The program allows the use of the following external devices for the communication processes:

1. RS232;

2. Dock-Station;

- b) The choice of the address list,

There can be loaded addresses lists, which contain information about the gas consumers (name, domicile and meter series).

These lists can be subsequently used in turn for the gas meters reading.

The lists are created by means of GazMBDprogram.

The selected list can be viewed entirely or there can be viewed only the consumers those have not been read.

- c) List deleting

Consumer's lists can be deleted, as needed.

The reading operations consist of the following:

- a) Current data reading

The program allows current data reading through the radio module. By operating this control, the following dialog box is displayed:

\*\*\*\*\*

Gas meter reading

Address: <-Manual->

All meters: <-No->

GIVE UP GO ON

ESC ENTER

\*\*\*\*\*

After pressing "Tab" key, the options for the address selection will displayed:

\*\*\*\*\*

Manual

Name 1 | Domicile 1 | Address 1 |

Name 2 | Domicile 2 | Address 2 |

.....

\*\*\*\*\*

In case there is no current list, only "Manual" option is displayed.

The meter can be read in turn, by selecting an address from the list or by entering the address with the keyboard, if <manual> option is selected.

If "All meters" is set up on "Yes", there will be read all the previously loaded meters, or only the meters that have not been read, as function of the chosen option.

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Multiple readings

Select: <-All meters-> <-Unread meters->

GO ON

ENTER

\*\*\*\*\*

The data thus read are grouped in a directory, and the file names are created on the basis of the serial information (identifier). The hand-held terminal will display the following data:

- the identifier (address)
- the measured volume (m3)
- current time
- current date

b) Manual data entering

The program also enables the manual entering of the following data:

- the identifier (address)
- the measured volume (m3)
- current time
- current date

GazMBDsoftware module has been intended to run under Windows 95, 98 and carry out the following:

The transfer of the current data stored in PSION hand-held terminal, and the deleting of the records from PSION hand-held terminal can be carried out by operating the controls of menu:

- Current data
- PSION data deleting

These functions are correlated with the similar functions of GazMBDprogram on PsionWorkabout hand-held terminal.

Data display in the view zone and their deleting by operating the controls of menu:

- View zone deleting
- Current data view

Viewing certain information from the data base by operating the controls of menu

- Search
- The first
- The preceding one
- The following
- The last

The users, passwords and consumers lists configuration by operating the controls of menu:

- Consumers
- PSION password
- Consumers list

The database can also be used by other specific applications: analysis, forecasting, billing etc.

Technical characteristics of remote reading system for gas meters are:

- The maximum number of consumers stored by the HHU (2M memory): 10,000 consumers;
- HHU autonomy: 24h;
- Data about the radio interface:
  - it uses the free frequency band (no license required);
  - communication channel frequency: 868 MHz;
  - radiated power: max. 3mW (5dBm);
  - the antenna: internally executed;
  - DB9 connector for RS232;
  - supply: Li battery, 3.6V (25 000 readings).
- One meter reading time length: 5 seconds.

#### IV. ABOUT REFERENCES

Submetering of natural gas consumption after a long time of relative stagnation is moving ahead rapidly to day based on new technologies: electronics based meters and advances in communications.

AMR metering replace not only the classical meters but also:

- the billing system,
- the reading of the meters and
- the administration of revenue collection.

The AMR capability could subsequently be an added in an evolutionary manner, in order to offer advantages over and above the simple payment function like added

- value service,
- fraud control,
- tariffs incentives and
- unattended dwelling

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