



The Hong Kong and China Gas
Company Limited

Supplementary Information for Hong Kong Award for Industry – Consumer Product Design

Automatic Meter Reading System

Introduction of the Company

The Hong Kong and China Gas Company Limited

History

The Hong Kong and China Gas Company Limited (HKCG) was established in 1862 and was the first privately run public utility in Hong Kong. Today, Towngas has laid 3,000 km of pipelines covering 85% of Hong Kong households and serving more than 1.4 million residential, commercial and industrial customers in Hong Kong. Town gas is manufactured in plants at Tai Po and Ma Tau Kok, both using naphtha as a feedstock. They have output capacities of 8.4 and 2.6 million cubic metres per day respectively.

Over the years, we have been driven by our company mission: to provide customers with a safe and reliable supply of gas and the caring, competent and efficient service they expect, while working to preserve, protect and improve our environment. We adopt a “total solution” approach in our offer of services and products to our customers, with the aim of solving their household needs and enhancing their quality of life.

Regarding residential markets, we have broadened our product range to meet the requirements of different households. This includes new water heaters in a variety of capacities and products for different customer segments. We have managed to diversify from the traditional use of towngas for cooking and water heating into new product applications, such as clothes drying, space heating and dehumidification.

It is the company mission of HKCG to provide high quality services to customers from installation to maintenance of appliances. We conducted a Regular Safety Inspection program to provide preventive maintenance services for domestic gas appliances. We schedule to inspect household once per every eighteen months. Accurate meter reading for billing purpose is another high quality services that HKCG provides for customers.

Introduction of the Product

Automatic Meter Reading System

General Introduction

Hong Kong has a population of 6.7 million living in about 2 million flats and houses. Most of these flats were situated in high rise buildings up to 50 stories with over 200 flats in each building. Meters are usually installed inside the flats and in most cases inside the kitchen cabinets. These meters are scheduled to be read once in every 3 months.

As is the case in many other countries, gaining access into the premises for meter reading is usually difficult, not only because the flats are vacant as the tenants may have gone out to work, but also the tenants are reluctant to allow strangers to intrude their privacy without appointment. Despite all these unfavorable conditions, HKCG still manages to have a high access rate. However, there are still meters which have not been read for a long period of time, and gas bills would have to be estimated under such circumstances.

Although it is quite clear that Automatic Meter Reading (AMR) may help to resolve the above issues, HKCG could not find any commercially available system suitable for the situations in Hong Kong. Cost is certainly one of the concerns. In addition there are doubts whether the signals generated from the densely congested flats can be effectively be received and centralized through the concrete walls and floors, most of them are embedded with reinforced steel bars. To meet this challenge, HKCG decided to develop a system by itself in 1996 and collaborates with a research team from a famous university in Peoples' Republic of China. After years' of effort, a prototype of a new AMR system that is technically and economically suitable for most densely populated cities was developed and examined in field with promising results in 2000.

The concept of HKCG's AMR system was first published at World Gas Conference at France in June 2000. As expected the poster presentation earned a spot light position at the Conference. With the encouraging field test results in the year of 2000, the AMR system was launched as a standard design for gas meter in 2001.

Development Journey of an Innovative AMR Technology

Tele-metering concrete jungle in Hong Kong is a challenge to AMR service providers

Hong Kong is a densely populated metropolitan city. Most of the residential buildings are high-rises and spread over the territory like a concrete jungle. We have a relatively low cost of meter reading by human. The system must be cost effective both in the installation and operation as compared to the existing metering practice. There is no available system, whether it is wire line or wireless type, that can fulfil the cost and performance requirements. In general, the wire line system is usually expensive in the installation stage. Traditional wireless AMR system cannot have enough coverage over the steel reinforced structure. Although contemporary mobile phone system can perform the function, the cost and the investment is too expensive for utilities.

Innovative idea to use gas pipe as a medium of RF signal transmission

After conceptual study, in particular with relevance to the environment of Hong Kong, a design combining RF transmission from the meters, limited signal cabling inside the building and Public Telephone Service Network (PTSN) line over the district was developed.

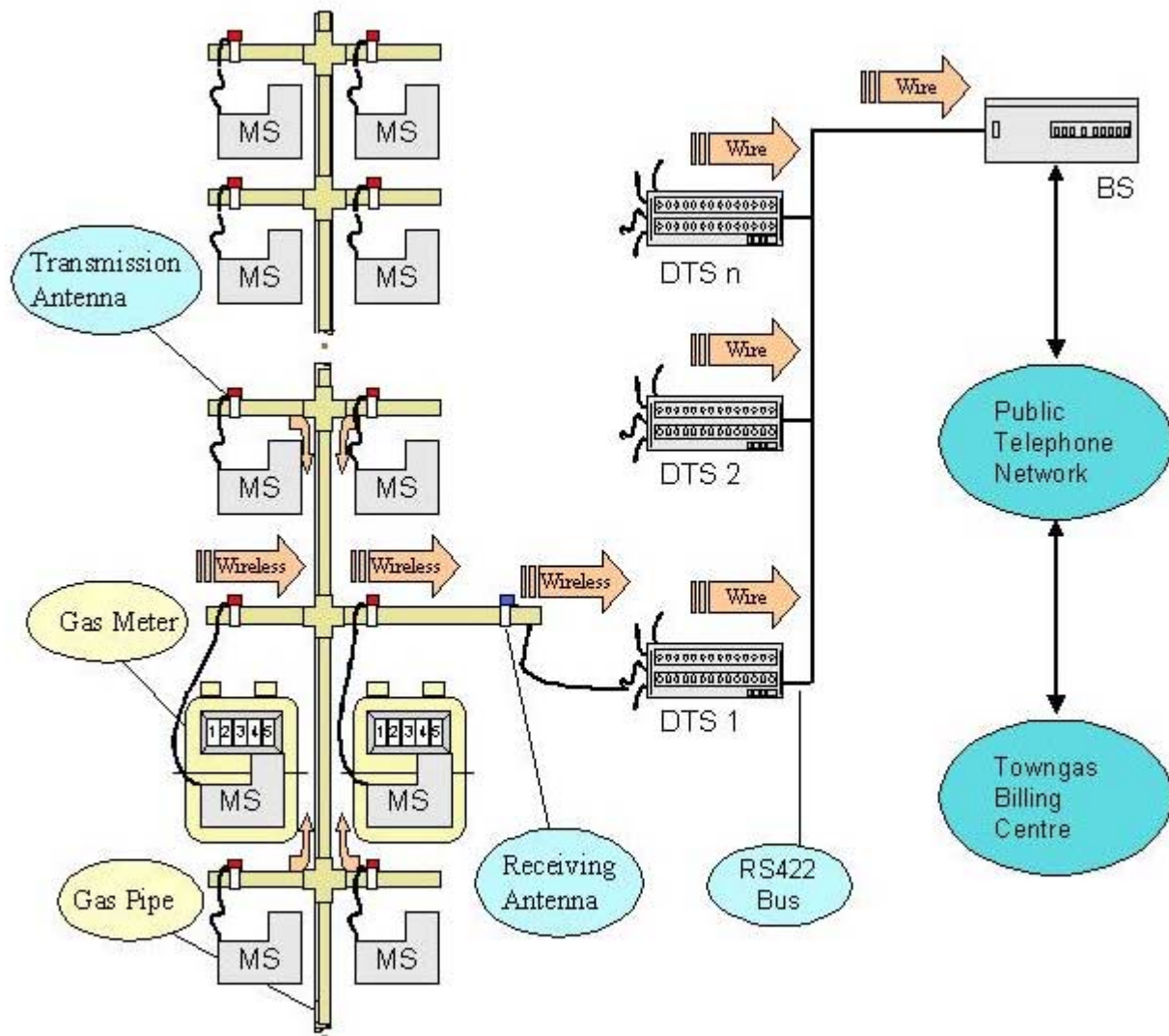
An innovative technology was developed to use the existing infrastructure, the gas pipe, as a medium of RF signal transmission. The “infrastructure” of gas riser provides an effective channel for data transmission. It enables the possibility of selecting a low cost wireless band as the signal carrier. The gas pipe arrangement directs the RF signal to pass through the steel reinforced structure, which is usually considered as the barrier of RF signal. In order to couple effectively the RF signal from electronic device to gas pipe, another innovative antenna was developed. It has the features of low cost and easy installation. The RF transmission device was designed to conform to Low Power Device (LPD) requirements stipulated by the Office of Telecommunication Authority (OFTA). Use of such device is free from license charge.



System Architecture

Primary data transmission between the MS and the receiving antenna is the heart and crucial part of the system. RF signals from the meter units are transmitted on a scheduled daily basis. Through the innovative design antenna, the signal was transmitted along the gas piping system and picked up remotely by the DTS through another antenna. This eliminates the unacceptable attenuation to RF signals caused by steel bar reinforced concrete slabs and window frames. Wire connection with signal cable between the receiving antenna, DTS and the BS performs the secondary data transmission. The tertiary part is conducted by local telephone network from BS to head-office. Each Base Station can take care of all meter readings within a housing estate.

System Architecture of HKCG AMR System



BS : Base Station

DTS : Data Transit Station

MS : Meter Station

Key Components of AMR System

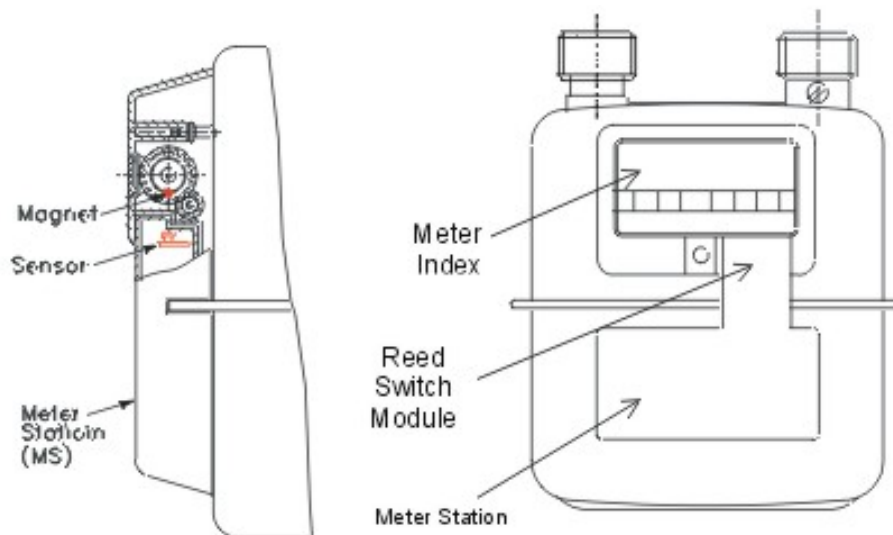
Meter

Traditionally we use diaphragm meter with meter index operated by mechanical gear drum. In order to provide means for electronic output, a magnet is incorporated into the gear drum of the index. When gas is passing through the meter the gear drum will rotate. A sensor is installed in the meter station to detect the number of revolution of the magnet and generates electric pulse signal accordingly.



Meter Station (MS) and Reed Switch Module

The function of Meter Station is to record the electric pulse signals, conduct data management and then transmit the gas consumption data to the DTS via an innovative antenna at a scheduled time. All these operations are controlled by a proprietary microprocessor working on a 3 V lithium battery. Hardware and software are designed for low power consumption to achieve 10-year working life of the meter station. An advance monitoring circuit is incorporated in the design to detect any abnormal working status of the meter such as low battery power. Anti-tampering design is adopted to secure the meter reading against illegal treatment on the meter index. It is a low power device interfaced with meter via the reed switch module. The Reed Switch Module is attached to the meter index and is tailor made for different types of meters with a reed switch sensor to convert the magnetic signal to electric pulse signal.

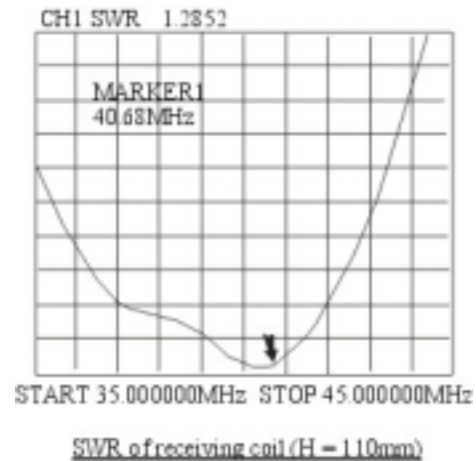


Key Components of AMR System

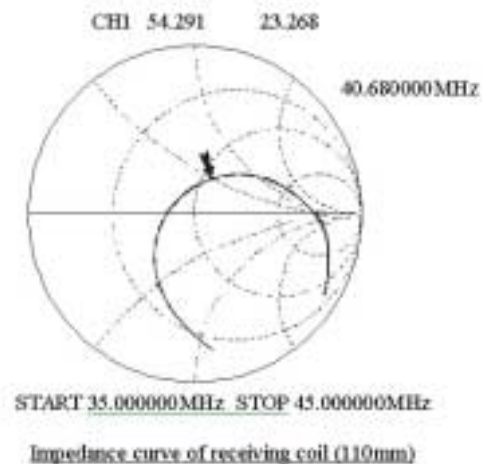
Innovative Capacitive Coupling Antenna

The findings that gas riser network is inherently an effective channel for RF data communication is a breakthrough on the success of the AMR system. It enables mature and low cost RF technology to be used for RF transmission overcoming the constraints induced by steel bar reinforced concrete slabs. The correct selection of frequency band to match with the specific impedance characteristic of gas pipe is another milestone on the application of the innovative technology.

The current arrangement of gas riser on outside wall of building plays an important role in selection of carrier frequency. 40.68MHz is an optimum selection regarding the SWR.



In order to make the coupling on the gas pipe more effective, the characteristic impedance among the transmission antenna, gas pipe and receiving antenna must be properly matched.

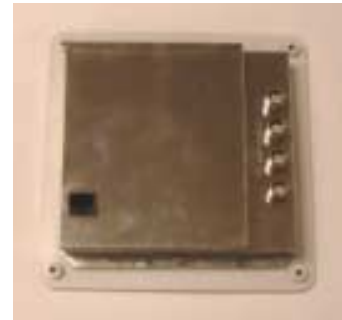


Key Components of AMR System

Data Transit Station (DTS)

DTS is installed in the common signal cable duct of the building. It has 4 receiving channels each couples to one gas riser and its receiving coverage is 3 floors to both upward and downward directions. Data is then relayed to BS upon receiving polling command from BS.

DTS is working at high sensitivity of about 5 dB μ V. The gas riser network is exposed to other potential interference around the atmosphere. To eliminate noise from the environment, data stream is used to synchronize with DTS via the pre-amble stream before the data is being captured and recognized by DTS. In addition, DTS has intelligent that only data of pre-programmed cluster of customers are stored and managed.



Base Station (BS)

The BS serves as the district concentrator to collect and manage data received from DTS. A modem is incorporated in the BS for communication with the head office through local telephone network. Self-developed software and proprietary protocol was developed to satisfy the particular data management requirement for meter reading.

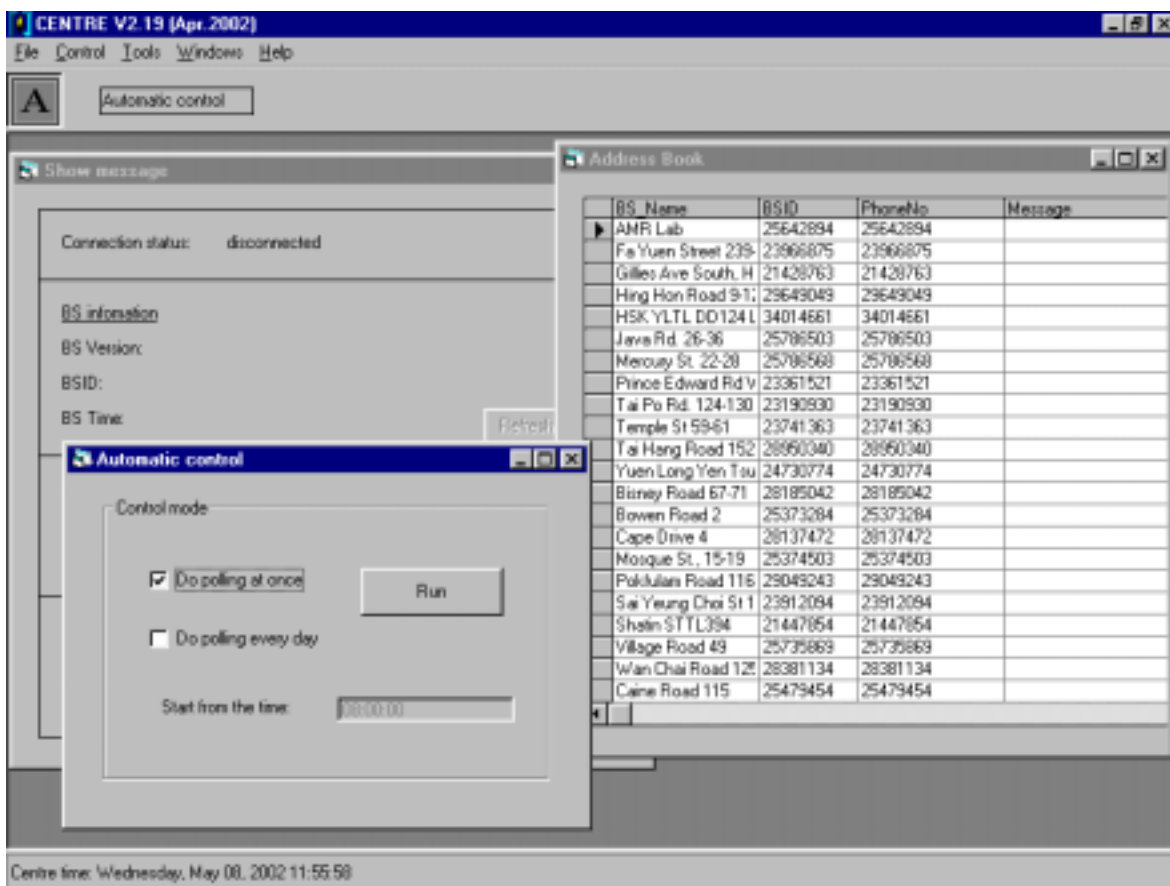
BS location –
outdoor sample



Key Components of AMR System

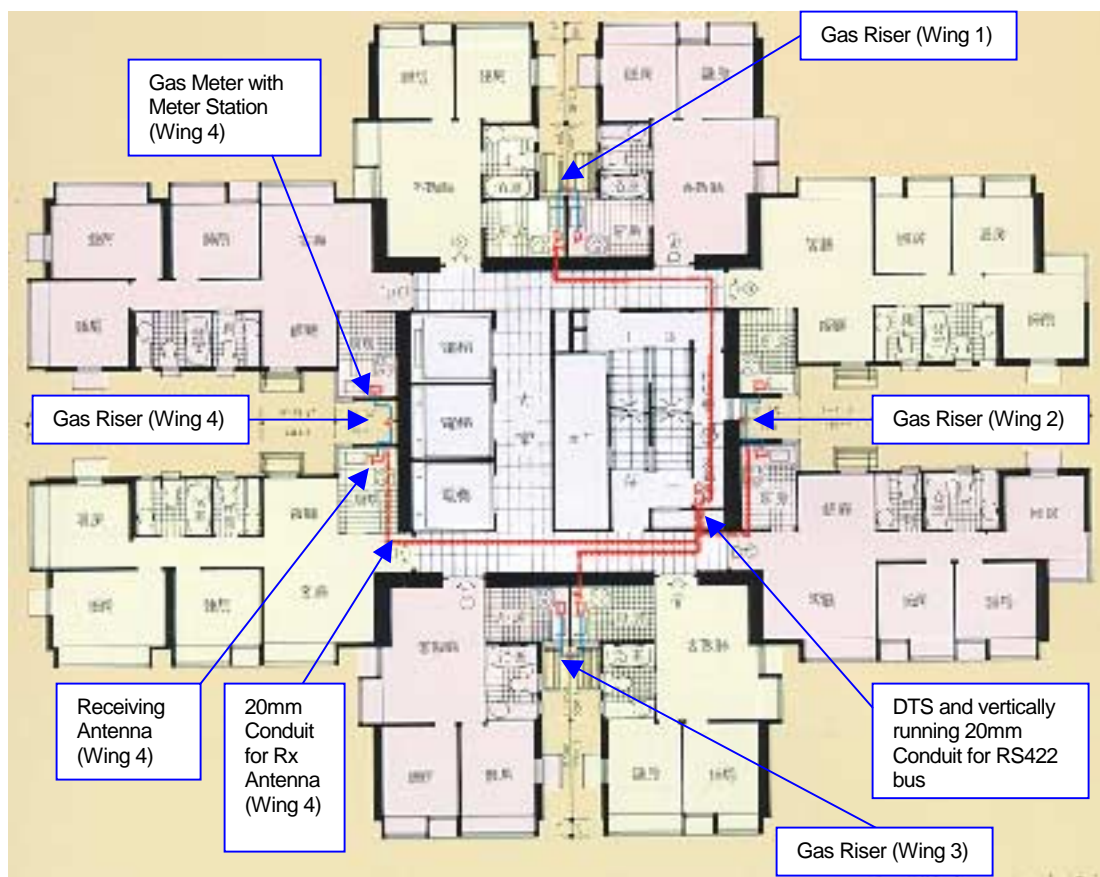
Centre and Billing System

Centre is a PC based processing unit. It automatically polls the selected Base Stations on a scheduled or on-demand basis. Remote data collected from each individual Base Station will be examined by checking algorithms at the Centre Terminal. Abnormal data will be sorted out for further investigation before the data is processed for billing purpose.



AMR integrated in Building Design

The design and installation of HKCG's AMR system is simple, and can easily be integrated into the gas pipes network. Limited conduits for the wiring of signal cable are required for communication between receiving antenna, Data Transit Station and Base Station. However it will not affect the building construction and design.



Typical layer of horizontally running conduits for every seven floors of building

Specifications

System Specifications		
Meter Station (MS)	➤ Transmit frequency	➤ 40.68 MHz
	➤ Battery voltage	➤ 3V lithium
	➤ Expected battery life	➤ 10 years
	➤ RF modulation	➤ FSK
	➤ Transmission period	➤ Once per day
	➤ Dimensions (mm)	➤ 75(H)x110(W)x30(D)
	➤ Transmission power	➤ <10mW
	➤ OFTA Licence	➤ Exemption (Low Power Device category)
Data Transit Station (DTS)	➤ Number of input channel	➤ 4
	➤ Centre frequency	➤ 40.68MHz
	➤ FM deviation	➤ +/- 7.5kHz
	➤ Dimensions (mm)	➤ 150(H)x150(W)x75(D)
	➤ Supply voltage	➤ 9~12Vdc supplied by Base Station
	➤ Serial port	➤ 1 x RS422
Base Station (BS)	➤ MPU	➤ AT89C55
	➤ Maximum capacity	➤ 127 DTS (2000 MS)
	➤ Serial ports	➤ 1 x RS422, 1 x RS232
	➤ Supply power	➤ 220Vac, 50Hz, 50W
	➤ Remote polling method	➤ Via PSTN / GSM to Centre
	➤ Dimensions (mm)	➤ 600(H)x500(W)x260(D)
Antenna	➤ Attenuation	➤ 2dB
	➤ Bandwidth	➤ 2MHz
	➤ Dimensions (mm)	➤ 15(H)x20(W)x25(D)

Conclusion

Remote meter reading is probably one of the fastest growing areas for meter manufacturing industry. To develop the world's FIRST AMR system for high rises is truly a challenging task. We appreciate that the AMR system we developed is unique, accurate and cost competitive to the conventional meter reading by human. The innovative utilization of gas piping as trunk for RF data transmission contributes to the success of the system. This new technology is extremely suitable for metropolitan cities like Hong Kong and certainly a preferred practice for remote metering of other utilities such as water meters especially for Asia markets where high rises are common. In addition to the primary meter reading function AMR would potentially act as a platform for value added services in future. It will form a communication bridge between utilities and its valuable customers. Since the launch of the AMR system in 2001, all major developers accept the AMR system as a standard provision for new housing projects.

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