Automatic Meter Reading

Antenna Technologies

Overview

Abstract

Utility Companies have incentives to apply Automatic Meter Reading Technologies:

- To reduce cost from manual meter reading/data entering
- To frequently probe utility usage and to be able to forecast utility usage
  - *Usage forecast can provide tremendous benefit for electricity production and distribution*
- To add supplemental function, such as meter reset, data communication and so on, into industrial and residential meter.

In order to prevent antenna tampering, it is usually required that the antenna be embedded inside the enclosure.

Metering environment might affect antenna performance (RFI).

We have developed antennas to fit the AMR requirement

Existing AMR Technologies

1. **Power Line Modem Based**
   - No wireless, no antenna
   - Noise and reflection within power line is difficult to reduce, causing poor data rate and low efficiency
2. **Wireless technologies based:**
   - Drive by technologies, which accounts about 60% of AMR today
     - In existence for over 15 years
     - Only save the meter reading labor
     - Can not probe meter frequently enough

     Not an ideal AMR technology!
   - WAN based Fixed Wireless network technology
     - Wide coverage, long distance data transmit ion
     - Have to pay air-time and data charge to cellular operators
   - Short-range radio based mesh network, such as 900MHz mesh, Bluetooth, WLAN based AMR
     - Don't pay for air time
     - Short range, from several meters up to 100 meters

Most utility firms are using a hybrid architecture:

- Multiple residential meters talk to each other, and a hub, using short-range radio
- The Hub, usually an industrial meter, uses WAN to perform long range data transfer

Antennas used in Wireless AMR

Considerations in choosing antennas for AMR applications

- Space available inside the enclosure
- Performance requirement
  - For short-range antenna needs to cover several meter to 100 meter range
  - For WAN or Fixed Wireless antenna, it has to pass OTA requirement set by operators
- Polarization, directivity
  - Vertically polarized, as Omni-directional as possible

Wireless technologies available

*** Print Circuit Board (PCB) antenna**
*** Planar Inverted F (PIFA)**
*** Monopole**
*** Ceramic Antenna**

Objects that could affect embedded antenna

Metallic objects inside the meter, such as current transformers, electrolytic capacitors and even the metal foil based warning labels, would affect embedded antenna performance

Current transformers

Electrolytic capacitors

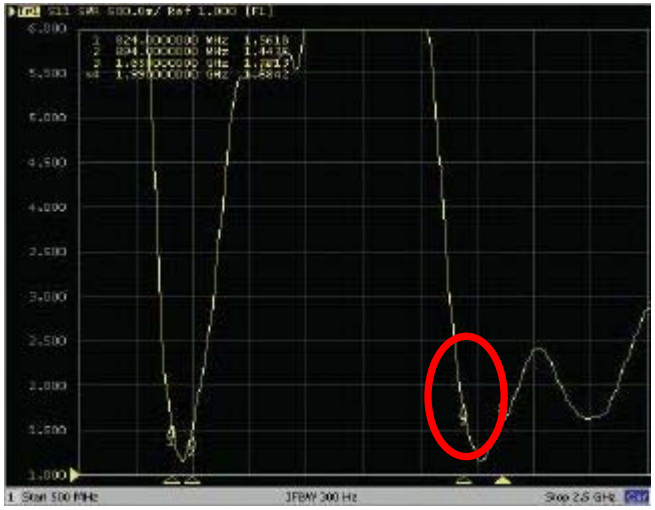
Foil based label

Label affects antenna VSWR

The measurement below clearly demonstrated how the foil based label changed antenna VSWR and de-tuned performance.

VSWA at 1850MHz changed significantly!

VSWR measured with foil label on



VSWR measured without foil label

AMR Antenna Comparison

	PCB Dipole	PIFA	Monopole	Ceramic
Dimensions to fit inside easily	No problem	Not easy	Need modification	No problem
Omnidirectional Pattern	Acceptable	Best	Acceptable	Uncertain
Polarization	Vertical	Vertical	Vertical	Uncertain
Typical Efficiency	60-70%	70%	50-60%	40%
Easy to fine tune	Yes	No	Yes	No
Overall	Highly recommended	??	??	Not recommended

AMR antenna technology comparison summary

- For various antenna options available, a PCB dipole antenna is the best fit for embedded AMR antenna
- If the monopole antenna can fit inside the industrial meter, it can meet customers requirement in most aspects
- PIFA antenna has obvious advantages and disadvantages. The amount of engineering work related to mechanical modification and electrical fine tuning prevents PIFA from being widely used in AMR applications
- Ceramic antenna have poor performance and are not fit for industrial meter application. They can be used in residential meters applying short-range, mesh networks where performance is not first priority.

Conclusions

- AMR Antennas that are embedded inside meter enclosure are affected by various objects inside meter or near the meter.
- Several different antenna technologies were evaluated for embedded AMR antenna design.
- Tetrafab and our China partners have developed a flexible PCB dipole antenna that applies to cellular, ISM and WLAN frequencies. This antenna can easily fit inside industrial and residential meters and it can achieve superior performance to meet AMR industry functional requirements.
- Additional fine tuning might still be recommended to achieve optimal performance