The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 2025

Volume 36, Pages 229-240

ICBAST 2025: International Conference on Basic Sciences and Technology

Remotely Read and Transfer Energy Meter Parameters in an RF and IoT Network

Goce Stefanov
Goce Delcev University

Vlatko Cingoski
Goce Delcev University

Bilijana Citkuseva-Dimitrovska
Goce Delcev University

Todor Cekerovski
Goce Delcev University

Abstract: In industrial facilities, process quantities are categorized into two main groups. The first group includes non-electrical variables associated with technological operations, such as pressure, flow, temperature, and level, which require conversion into electrical signals through sensors and converters. The second group consists of electrical metrics related to electricity distribution and consumption, which are already in electrical signal form and do not need conversion. A key similarity between signals in both groups is the necessity for accurate measurement, collection, visualization, and distribution. Modern measurement systems can visualize quantities on displays, transmit data remotely, and store it for future analysis.This paper examines challenges related to the second group of signals, specifically the measurement of electrical data from installed energy meters (EM). These smart EM operate under EU regulations and are used in both industrial and residential settings. They calculate parameters like active and reactive power based on measured values of voltage and current. However, a limitation exists: reading and data collection are conducted manually on-site, preventing remote access. To overcome this challenge, the paper proposes an electronic system connected to existing smart EM, enabling local data transmission to personal computers and remote access via Intranet and IoT networks. This innovation could significantly improve energy data management and monitoring processes.

Keywords: Energy meter, Remote transfer data, RF network, IoT network

Introduction

Electricity metering is a crucial component of electricity production, distribution, and consumption. Therefore, accurate billing for energy usage and timely calculations are of utmost importance. To eliminate the need for human involvement in data collection, automatic reading of meters is necessary (Garrab, Bouallegue, Ben Abdullah, 2012; Koay, Cheah, Chong, Shum, Tong, Wang, Zuo and Kuek , 2003; Himanshu, Patel, 2018).

Currently, most energy meters used in our country can measure and monitor electricity, but they do not allow for remote access. These energy meters operate according to relevant protocols and standards set by EU regulations and beyond. They are installed not only in industries but also in residential homes. Based on voltage and current consumption, these meters calculate various parameters related to power consumption, including active and reactive power, as well as active and reactive energy. A significant issue with the equipment installed to date is that although the energy meters output measured values through a communication port, data

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

reading, and collection are done manually on-site. This means there is no option for remote reading or data distribution through intranet or internet networks.

Smart energy meters (SEMs) can help address various challenges by providing remote services to consumers through radio frequency (RF) and Internet-of-Things (IoT) networks (Devadhanishini, 2019; Mohammad Hossein Yaghmaee, 2018; Bibek Kanti Barman, 2017). This paper focuses on the design and implementation of an electronic system that connects to these SEMs, allowing the transmission of measurement data both locally to a personal computer and remotely through intranet and IoT networks. Timely reading and calculation of the data obtained from electricity metering are crucial for accurate billing of energy usage. Therefore, to eliminate the need for human involvement in data collection, automatic reading of the meters is essential.

Design of the Proposed Electronic System

The fundamental concept of the proposed electronic system design is to communicate with existing SEMs and distribute data regarding electricity consumption both locally and remotely within the IoT network. Figure 1 presents a simple block diagram of an SEM that has been designed and prototyped in this paper.

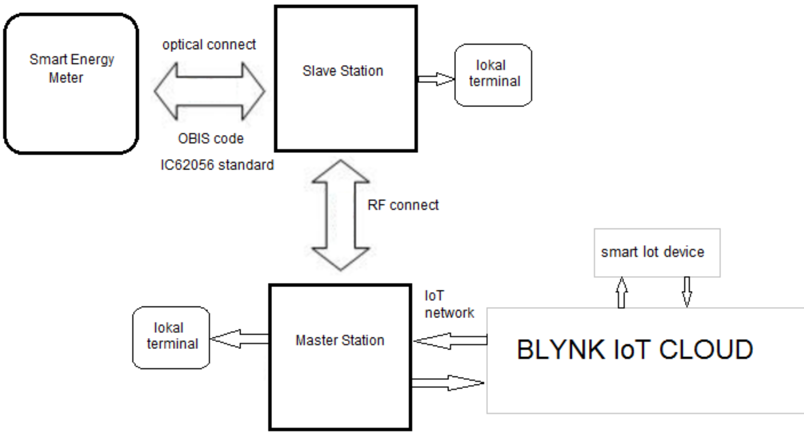


Figure 1. Simple block diagram on the proposed SEM system.

Figure 1 illustrates the connection of the SEM to a Slave station via an optical link, which consists of a dual configuration of an infrared phototransistor and an LED. This connection complies with the appropriate OBIS code and the IEC 62056 standard, as referenced in (Bibek Kanti Barman, 2017), (Subsystems, n.d.) and (IEC62056 protocol standard, n.d). The Slave station is then linked to the Master station through a bidirectional RF connection, as noted in (Citkuseva Dimitrovska, Biljana, and Zafirov, Elena and Stefanov, Goce, 2024) and (Stefanov, Goce and Cingoski, Vlatko, 2024). From the Master station, data is distributed using a Wi-Fi connection within the IoT network, making it accessible on a cloud server and via IoT mobile devices such as tablets and smartphones. This system enables visualization of data from the SEM on local terminals connected to both the Slave and Master stations, as well as within the wider IoT network.

The proposed design of the new electronic system, illustrated in Figure 1, includes both Slave and Master stations. Before delving into their detailed design, it is crucial to collect data on an SEM that operates by sending and receiving data through specialized equipment, utilizing an appropriate protocol. Consequently, a thorough understanding of this protocol is necessary.

Smart Meters

Smart meters are digital devices that measure and record electricity, gas, or water consumption in real-time, transmitting this information to utility companies. As a crucial part of advanced metering infrastructure, smart meters are becoming essential tools for modern energy management. With energy consumption and efficiency becoming critical issues, these devices provide an innovative solution for effectively managing energy metering in households, small businesses, and commercial settings.

In the past decade, smart meter installations have tripled, and they are on track to make up even 93% of all new metering systems. This shift is transforming the interaction between utilities and consumers regarding energy resources. Unlike traditional analog meters, which require manual readings by meter readers, smart meters deliver accurate and current consumption data. This allows utilities and consumers to monitor and manage energy use more efficiently.

Furthermore, smart meters are vital for developing smart grid infrastructure – a modernized electrical grid system that utilizes digital technology to improve the reliability, efficiency, and sustainability of electricity distribution (Smart meter, n.d.).

How Do Smart Meters Work

Smart meters contain a metering device that accurately measures energy consumption using digital technology. The types of sensors and measurement techniques employed vary depending on the type of energy being measured. For electricity smart meters, sensors monitor the voltage and current flowing through electrical circuits. These values are multiplied to calculate power consumption, which is measured in watts. By integrating the power consumption over time, the meter can determine the total electricity used, measured in kilowatt-hours.

In contrast, natural gas and water meters utilize flow sensors to measure the volume of gas or water passing through the meter. These sensors may employ various technologies, including ultrasonic, turbine, or diaphragm-based methods. The smart meter then calculates energy consumption based on the volume of gas or water used and the energy content of each respective resource.

How Do Smart Meters Send Data?

Once a smart meter measures and records energy consumption data, its communications module is responsible for transmitting this information to the water, gas, or electric company using one of the following methods:

- ***Radiofrequency (RF) Signals:*** Many smart meters transmit data wirelessly via RF signals. This method is cost-effective and allows for long-range communication, making it suitable for large-scale deployments. However, RF signals can be susceptible to interference from other wireless devices and may require additional infrastructure, such as repeaters or gateways, to ensure reliable communication.

- ***Cellular Networks:*** Some smart meters utilize existing cellular networks (such as 4G or 5G) for data transmission. This approach offers widespread coverage and is generally more resistant to interference than RF signals. However, using cellular networks can incur additional data transmission costs and may not be suitable for areas with limited or unreliable cellular coverage.

- ***Broadband Connections:*** Smart meters can also communicate through broadband connections, like DSL and fiber-optic networks. This method provides fast and reliable data transmission however may require significant infrastructure investments, particularly in rural or remote areas where broadband coverage might be limited.

- ***Power Line Communication (PLC):*** PLC technology enables smart meters to transmit data over existing power lines, avoiding the need for additional communication infrastructure. This method can be cost-effective and provide reliable communication, but its performance may be affected by electrical noise and the distance from the substation.

Regardless of the communication method used, data transmission typically occurs at regular intervals (e.g. every 15 minutes, 30 minutes, or hourly). This ensures that utility companies receive up-to-date consumption information for billing, demand response, and grid management purposes. It's important to note that currently, not all energy meters within our country are smart meters. Many existing energy meters do not have a built-in interface for data distribution, which means the option for remote reading is not available. The electronic system proposed in the paper was specifically designed to address this need.

The diagram in Figure 2 illustrates a block diagram of a smart energy meter. Many smart energy meters have an output port that allows communication with an external local reader using either the IEC 62056-21 protocol or DLMS with OBIS code, (Electricity meters, n.d.).

The OBIS code is used to identify the corresponding device value. It is a text string formatted according to the OBIS standard (see IEC 62056-61, (Subsystems, n.d.), (Energy meter, n.d.). A simpler and older version of this code is the EDIS code, which does not include groups A and B (as mentioned further below). This code is utilized in the PROMOTIC system for the Pm IEC62056 communication driver.

When the driver receives a message of the Readout- Values readout type, it saves the extensive text string into the variable "ResultList." The OBIS value code appears at the beginning of each row in the string. This code can consist of up to six group sub-identifiers, labeled A to F. Not all of these identifiers may be present; for instance, groups A and B are frequently omitted. The groups are separated by unique separators, which help determine the group to which each sub-identifier belongs.

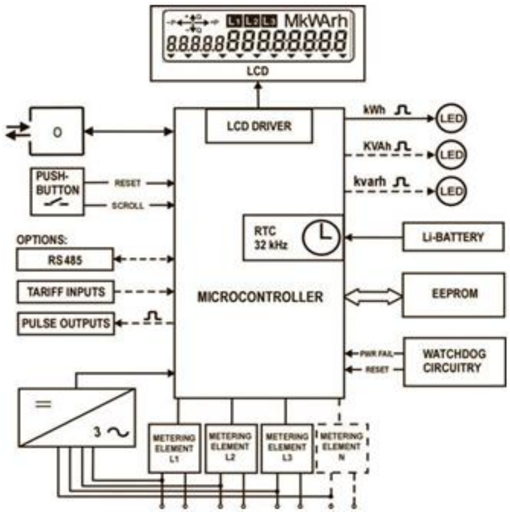


Figure 2. An example of a block diagram of a SEM.

In general, the following separates could be found:

A-B:C.D.E*F

- **The A group** specifies the measuring medium, represented by numerical codes: 0 for abstract objects, 1 for electricity, 6 for heat, 7 for gas, 8 for water, and so on.
- **The B group** indicates the channel. Devices with multiple channels that generate measurement results can separate these results by channel.
- **The C group** defines the physical value being measured, such as current, voltage, energy, level, or temperature.
- **The D group** specifies the quantity computation result derived from a specific algorithm.
- **The E group** defines the measurement type based on the specifications outlined in groups A to D, allowing for individual measurements (i.e. switching ranges).
- **The F group** further separates the results defined by groups A to E, typically used to specify individual time ranges.

The IEC 62056-21 protocol is supported through the optical IR port COM1, which is the default mode for this port, as well as via the serial port COM3. A built-in switch adheres to the IEC 62054-21 and IEC 62052-21 standards, allowing for energy registration in up to four different tariffs. Figure 3a) illustrates an SEM connected to an optical IR sensor for data transmission with an external device, while Figure 3b) depicts an optical sensor featuring IR transmission and receive diodes.

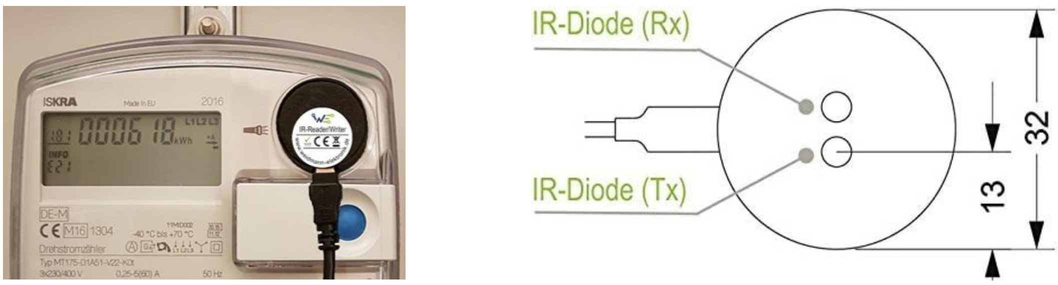


Figure 3. a) an SEM with connected optical IR sensor, and b) an optical sensor with IR-diodes (Rx and Tx).

Table 1. Examples of OBIS code used for electric power measurement

OBIS Code	Description
	1: Active energy registers:
1.8.0	Positive active energy (A+) total [kWh]
1.8.1	Positive active energy (A+) measured in tariff T1 [kWh]
1.8.2	Positive active energy (A+) measured in tariff T2 [kWh]
1.8.3, 1.8.4, etc.	Positive active energy (A+) measured in tariff T3, T4, etc. [kWh]
...	
2.8.0	Negative active energy (A+) total [kWh]
2.8.1	Negative active energy (A+) measured in tariff T1 [kWh]
2.8.2	Negative active energy (A+) measured in tariff T1 [kWh]
2.8.3, 2.8.4 ... etc.	Negative active energy (A+) measured in tariff T3, T4, etc. [kWh]
...	
15.8.0	Absolute active energy (A+) total [kWh]
15.8.1	Absolute active energy (A+) measured in tariff T1 [kWh]
15.8.2	Absolute active energy (A+) measured in tariff T2 [kWh]
...	
16.8.0	Sum active energy without reverse blockade (A+ – A-) total [kWh]
16.8.1	Sum active energy without reverse blockade (A+ – A-) measured in tariff T1 [kWh]
16.8.2	Sum active energy without reverse blockade (A+ – A-) measured in tariff T2 [kWh]
...	
	2: Reactive energy registers:
3.8.0	Positive reactive energy (Q+) total [kVarh]
3.8.1	Positive reactive energy (Q+) measured in tariff T1 [kVarh]
3.8.2	Positive reactive energy (Q+) measured in tariff T2 [kVarh]
3.8.3, 3.8.4, etc.	Positive reactive energy (Q+) measured in tariff T3, T4, etc. [kVarh]
...	
4.8.0	Negative reactive energy (Q-) total [kVarh]
4.8.1	Negative reactive energy (Q-) measured in tariff T1 [kVarh]
4.8.2	Negative reactive energy (Q-) measured in tariff T2 [kVarh]
4.8.3, 4.8.4, etc.	Negative reactive energy (Q-) measured in tariff T3, T4, etc. [kVarh]
...	
5.8.0	Imported inductive reactive energy in 1-st quadrant (Q1) total [kVarh]
5.8.1	Imported inductive reactive energy in 1-st quadrant (Q1) measured in tariff T1 [kVarh]
...	
6.8.0	Imported capacitive reactive energy in 2-nd quadrant (Q2) total [kVarh]
6.8.1	Imported capacitive reactive energy in 2-st quadrant (Q2) measured in tariff T1 [kVarh]
...	
7.8.0	Exported inductive reactive energy in the 3-rd quadrant (Q3) total [kVarh]
7.8.1	Exported inductive reactive energy in the 3-rd quadrant (Q3) measured in tariff T1 [kVarh]
...	
8.8.0	Exported capacitive reactive energy in 4-th quadrant (Q4) total [kVarh]
8.8.1	Exported capacitive reactive energy in 4-th quadrant(Q4) measured in tariff T1 [kVarh]
....	

Transfer SEM Data Using RF and IoT Networks

Figure 4 shows a block diagram of the proposed electronic data transfer system featuring both Slave and Master stations, each equipped with an RF module and a microcontroller (NodeMCU ESP8266-12E). This configuration allows for connecting energy meter readings within local and IoT networks. The Slave microcontroller collects data from the energy meter using an optical sensor and transmits it to the Master microcontroller via RF communication. The Master microcontroller is connected to the IoT network through Wi-Fi and linked to a local terminal via a UART port, enabling data display on a serial screen and integration into the intra-company network.

This hardware setup efficiently captures and visualizes energy meter values while facilitating data distribution within the IoT network. The Slave and Master stations include the NodeMCU ESP8266-12E microcontrollers, the nrf24l01 RF module (Arduino, n.d.), (Single chip 2.4 GHz, n.d.) and essential hardware components. The NodeMCU8266-12E is embedded in the Slave station due to its greater memory capacity and faster processor, which are important for handling the size and speed of the string data transmitted by the SEM. The same microcontroller is also integrated into the Master station to facilitate connectivity within the IoT network.

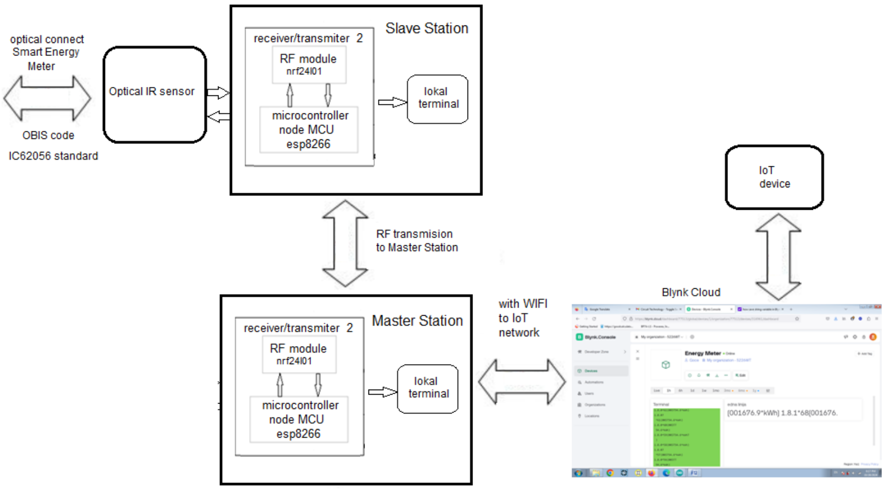


Figure 4. A block diagram illustrating the interconnection between the Master and the Slave stations.

Features of the Used Hardware

a) *NRF24L01 Module*

The NRF24L01 is a single-chip radio transceiver module that operates within the 2.4 to 2.5 GHz frequency range i.e. ISM band. This module includes a fully integrated frequency synthesizer, power amplifier, crystal oscillator, demodulator, modulator, and an enhanced ShockBurst protocol engine. The output power, frequency channels, and protocol settings can be easily programmed through an SPI interface. Additionally, it features built-in Power Down and Standby modes, allowing for efficient power savings. Figure 5 illustrates various types of electronic boards associated with the NRF24L01 module and its pinout.

a) NRF24L01 module, and his pinout b) NRF24L01 E01-ML01DP5 module

Figure 5. The electronic board of the NRF24L01, a) module with pinout, b) long-range NRF24L01 E01-ML01DP5 module.

Figure 5a) illustrates a typical electronic board of the NRF24L01 module along with its pinout for a communication range of 100 meters in free air. Figure 5b) represents the NRF24L01 E01-ML01DP5, which has a range of 2.500 meters. Module E01-2G4M27D nRF24L01P+PA+LNA is capable of reaching a range of up to 5.000 meters. Table 2 outlines the pinout configuration of the NRF24L01 module.

Table 2. Pinout configuration on NRF24L01 module

Pin Number	Pin Name	Abbreviation	Function
1	Ground	Ground	Connected to the system's ground
2	Vcc	Power	Powers the module using 3.3V
3	CE	Chip Enable	Used to enable SPI communication
4	CSN	Ship Select Not	This pin must always be kept high; otherwise, it will disable the SPI
5	SCK	Serial Clock	Provides the clock pulse using which the SPI communication works
6	MOSI	Master Out Slave In	Connected to the MOSI pin of the MCU to enable data reception from the MCU
7	MISO	Master In Slave Out	Connected to the MISO pin of the MCU, to enable sending data from the MCU
8	IRQ	Interrupt	This pin is active low and is used only when an interrupt is required

The main features of the NRF24L01 module are:

- RF transceiver module at 2.4 GHz frequency
- Operating Voltage: 3.3V
- Nominal current: 50mA
- Range: 50 – 5000 m
- Operating current: 250mA (max)
- Communication Protocol: SPI
- Baud Rate: 250 kbps – 2 Mbps.
- Channel Range: 125
- Maximum pipelines/node: 6
- Low-cost wireless solution

The NRF24L01 is a wireless transceiver module, which means it can both send and receive data. It operates at a frequency of 2.4 GHz, which falls within the ISM band, making it legal to use in almost all countries for engineering applications. When operating efficiently, the module can cover a distance of up to 100 meters (approx. 300 feet), making it an excellent choice for wireless remote-controlled projects. This module operates at 3.3V, allowing for easy integration with both 3.2V and 5V systems. Each module has an address range of 125 and can communicate with up to 6 other modules, enabling multiple wireless units to interact within a designated area. This capability allows for the creation of mesh networks or other types of networks using this module, making it ideal for various practical applications. The NRF24L01 module communicates using SPI (Serial Peripheral Interface). It can be used with either a 3.3V microcontroller or a 5V microcontroller equipped with an SPI port. Detailed usage instructions for interfacing this module via SPI can be found in the datasheet.

The circuit diagram in Figure 6 illustrates how to connect the module with a 3.3V microcontroller. However, the process is similar to a 5V microcontroller. The SPI pins (MISO, MOSI, and SCK) should be connected to the corresponding SPI pins on the microcontroller, while the signal pins (CE and CSN) should be connected to the GPIO pins of the MCU. There are readily available libraries, such as the R24 Library, which can be used for interfacing this module with Arduino.

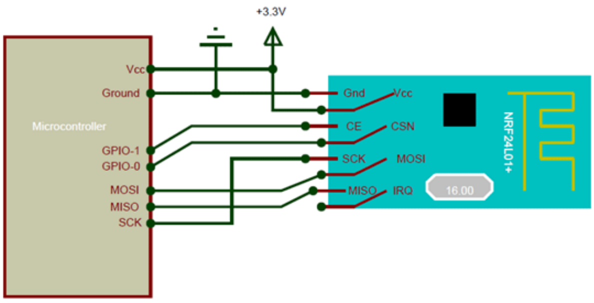


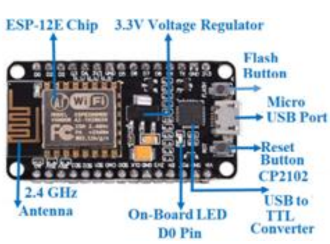
Figure 6. Connection of an NRF24L01 module with a microcontroller.

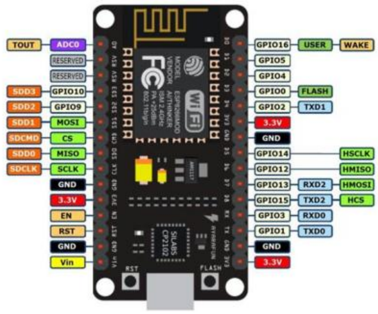
With the help of various libraries such as R24 Library, the NRF24L01 can be easily interfaced with an Arduino using just a few lines of code. If you are using a different microcontroller, you will need to refer to the datasheet to understand how to establish SPI communication. The NRF24L01 module can be a bit tricky to use, especially since there are many cloned versions available on the market. For troubleshooting, it's recommended to add 10µF and 0.1µF capacitors in parallel to the Vcc and Ground pins. Additionally, ensure that the 3.3V power supply is clean and free from any noise.

b) Microcomputer NodeMCU ESP8266-12e

The NodeMCU ESP8266 development board features the ESP-12E module, which incorporates an ESP8266 chip equipped with a Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor supports Real-Time Operating Systems (RTOS) and operates at an adjustable clock frequency of 80 MHz to 160 MHz. The NodeMCU board includes 128 KB of RAM and 4 MB of Flash memory for storing data and programs. With its high processing power, built-in Wi-Fi and Bluetooth capabilities, and Deep Sleep operating features, it is well-suited for Internet of Things (IoT) projects.

The NodeMCU can be powered via a Micro USB jack or the VIN pin (external supply pin). It supports various interfaces, including UART, SPI, and I2C. Figure 7 illustrates the NodeMCU ESP8266 and its pinout.





a) the controller b) the pinout

Figure 7. The NodeMCU ESP8266 microcontroller.

NodeMCU board is an open-source firmware and development board designed specifically for IoT applications. It includes firmware that operates on the ESP8266 WiFi SoC from Express Systems, along with hardware based on the ESP-12 module, and it can be easily programmed using the Arduino IDE.
The essential specifications and features of the NodeMCU ESP8266 controller are as follows:

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7 – 12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug-n-Play
- PCB Antenna
- Sized module to fit smartly inside your IoT projects

c) Optical Sensor

These optical probes with a TTL interface are bi-directional communication devices that use infrared light. When connected to a computer or handheld terminal, they enable galvanically isolated communication with smart electricity and gas meters.

The optical IR TTL to IR converter, identified as MY014, was utilized in the designed prototype. This optical communication sensor employs infrared LED technology to create a galvanically isolated, bi-directional communication link between computers and electric utility meters. It is used for retrieving meter data, conducting site diagnostics, and making programming adjustments. Figures 8a and 8b show the front and back sides of the optical IR sensor used in the electronic system.

a) frontside b) backside

Figure 8. Optical IR sensor used in the proposed electronic system.

- The key features of the IR TTL sensor are as follows:

- It facilitates two-way serial communication with the meter using infrared (IR) light.
- It is compatible with IEC and MID meters and operates using the DLMS/COSEM protocol.
- The existing RS485 interface allows for remote connection.
- The voltage input ranges from DC 3.3V to DC 12V.
- A two-color (red/green) communication indicator blinks during communication.
- The sensor is attached to the smart meter using a permanent magnet.

Figure 9 illustrates the electrical circuit for the infrared optical sensor.

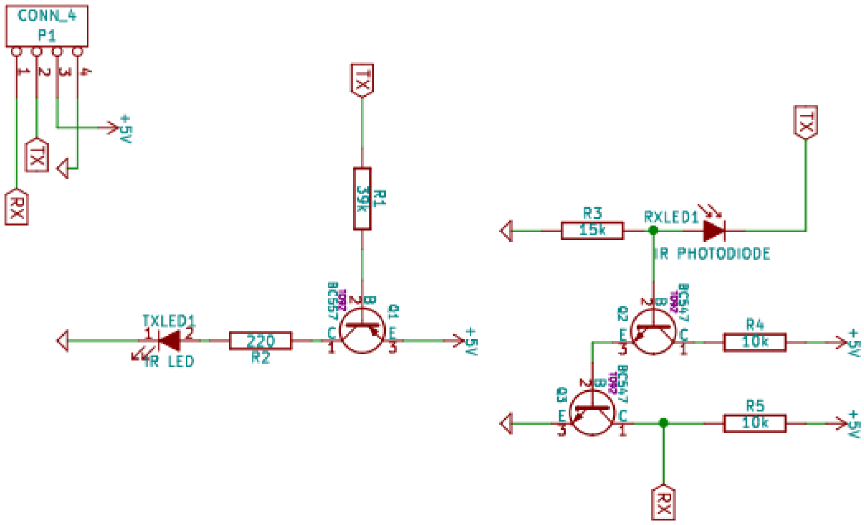
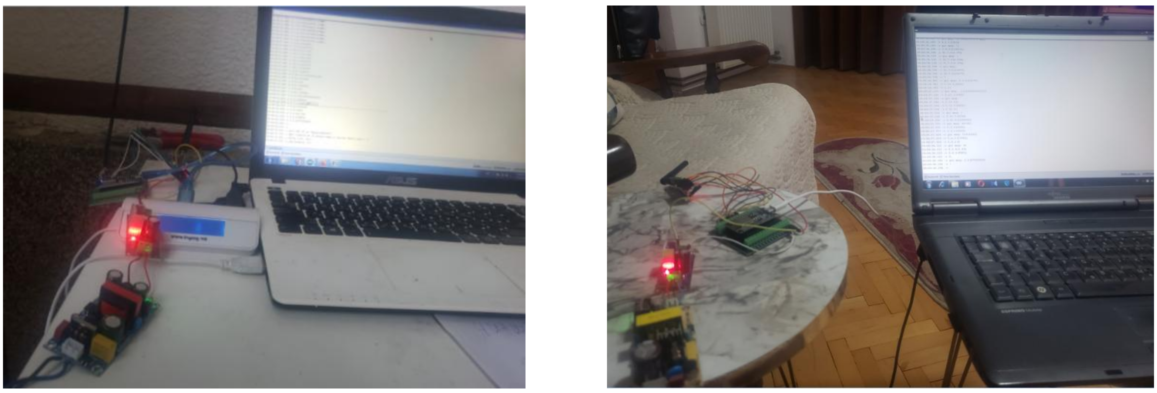


Figure 9. The electrical circuit diagram for the infrared (IR) optical sensor.

Experimental Results

Figure 10a) illustrates the prototype on the Slave station, while Figure 10b) presents the prototype on the Master station, which is connected to laptop computers functioning as terminals. These laptops display the SEM parameters on their screens. Figure 11a) features a screenshot from the serial monitor, showcasing the visualization of the SEM parameters, and Figure 11b) presents another screenshot from the serial monitor alongside some Arduino code.



a) test bench at the Slave station b) test bench at the Master station

Figure 10. Prototype on design electronic system for transfer SEM parameters in RF and IoT network.

Furthermore, the data collected from the proposed electric system can be transferred to a mobile device of our choice or stored on our cloud network. Figure 12a) illustrates a data screen on a mobile device displaying information transferred from an electronic system within the IoT network, while Figure 12b) shows a screen from the IoT Blynk cloud network (Blynk cloud, n.d.). As a result, the electronic system designed in this way is connected to Blink Cloud. This allows users to transmit and access the parameters of the SEM from any other hardware linked to the same cloud channel, regardless of geographical location.

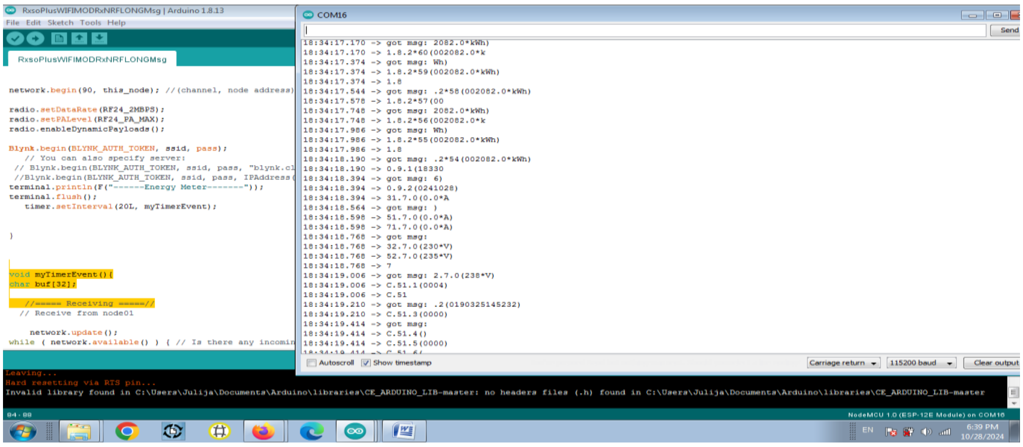
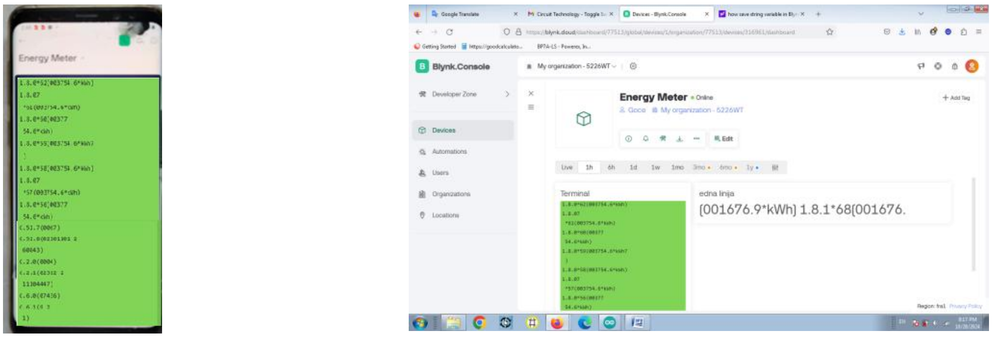


Figure 11. Screenshot from the serial monitor displaying the parameters of the scanning data from the SEM with some Arduino code in the background.



a) measured data shown on a mobile device b) measured data displayed on the screen of the IoT Blynk cloud network.

Figure 12. The display of the measured data by the SEM within the IoT network.

Advantages of the Designed Electronic System

The paper presents a solution that enables the transfer of parameters from smart energy meters (SEM) to RF-intra and IoT networks.

- The primary benefit of the designed electronic system is its ability to transmit and read measurement parameters from permanently installed smart energy meters (SEMs) remotely.
- The proposed system consists of Slave and Master stations, which allow for reading the parameters of the SEM both locally, at the site next to the meter, and remotely through an intranet created using an RF connection between the Slave and Master stations.
- The implemented Master Station, equipped with built-in software tools and a suitable NodeMCU microcontroller, facilitates the integration of SEM parameters into an IoT network.
- The RF modules used in this system have been tested and can successfully transmit process data over distances ranging from 100 to 5.000 meters.
- Connecting the electronic system to the Blink cloud enables the transmission and reading of SEM parameters from any other hardware connected to the same cloud channel, regardless of geographical location.

Conclusions

The paper presents the design and experimental realization of a prototypical electronic system for transferring and reading the parameters of installed energy meters from a distance. The system consists of two components: a Slave station located next to the energy meter and a Master station situated between 100 and 5.000 meters away. The connection between the Slave and Master stations is established using radio frequency (RF) modules, which are connected to smart NodeMCU microcontrollers at both stations. The Master station is equipped with a built-in Wi-Fi interface. This setup allows for the local reading of energy meter parameters at the Slave station and remote access at the Master station. With the hardware and software tools implemented in the system, data from the Master station can be transmitted and accessed within a local network. Furthermore, the design allows for the distribution of collected data to IoT cloud services and mobile smart devices such as smartphones and tablets.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

Acknowledgements or Notes

* This article was presented as an oral presentation at the International Conference on Basic Sciences and Technology (www.icbast.net) held in Budapest/Hungary on August 28-31, 2025.

References

Bibek, K. B. (2017). *Smart meter using ıot*. Department of International Electronics and Electrical Engineering. IEEE.

Blynk cloud. (n.d.). Retrieved from https://blynk.cloud

Citkuseva - Dimitrovska, B., Zafirov, E., & Stefanov, G. (2024). SCADA system for process data exchange in master slave RF and Iot network. *The Eurasia Proceedings of Science Technology Engineering and Mathematics, 28*, 554-564.

Dejan. (n.d.). *nRF24L01 – How ıt works, arduino ınterface, circuits, codes*. HowToMechatronics. Retrieved from https://howtomechatronics.com/tutorials/arduino/arduino-wireless-communication-nrf24l01-tutorial/

Devadhanishini, A. Y., Malasri, R. K., Nandinipriya, N., Subashini, V., & Gowri, P. G. P. (2019). Smart power monitoring system using IoT. *5th International Conference on Advanced Computing & Communication Systems (ICACCS)*, 813–816.

Electricity meters. (n.d.). *Iskraemeco MT174 manual*. Iskraemeco. Retrieved from https://www.manualslib.com/manual/139 1353/Iskraemeco-Mt174.html

Energy meter. (n.d.). *IEC 62056-21 and derivatives.* Github. Retrieved from https://github.com/lvzon/dsmr -p1-parser/blob/master/doc/IEC-62056-21-notes.md.

Garrab A., Bouallegue A., Ben Abdullah. (2012). A new AMR approach for energy savings in Smart Grids using Smart meter and partial power line communication,. *IEEE First International Conference on ICICS*, *3.*

IEC62056 protocol standard. (n.d.). Retrieved from https://github.com/lvzon/dsmr-p1-parser/blob/master/doc/IEC-62056-21-notes.md.

Koay, B. S., Cheah, S. S., Y. H., Chong, P. H., Shum, P., Tong, Y. C., Wang, X. Y., Zuo, X., & Kuek, H. (2003). Design and implementation of Bluetooth energy meter. *Proceedings of the 4th International Joint Conference of the ICICS, 3*, 1474–1477.

Merola, P. (2011). ARM-based energy management system using smart meter and Webserver. *IEEE İnstrumentation and Measurement Technology Conference* (pp. 1-5). Beijing.

Mohammad, H. Y. (2018). Design and ımplementation of an ınternet of things based smart energy metering. *6th IEEE International Conference on SmartEnergy Grid Engineering.*

Patel, H. K. (2018). Arduino-based smart energy meter. *2nd International Conference on Electrical Engineering and Information & Communication Technology (ICEEICT).*

Single chip 2.4 GHz. (n.d). *Single-chip 2.4 GHz transceiver NRF24L01, Nordic Semiconductor ASA VestreRosten 81, N-7075 Tiller*, Norway.

Smart meter. (n.d). *What are smart meters?*. IBM. Retrieved from https://www.ibm.com/topics/smart-meter

Stefanov, G., & Cingoski, V. (2024). Implementation of SCADA system for remote monitoring and power metering in RF and IoT networks. *Balkan Journal of Applied Mathematics and Informatics (BJAMI), 7*(1), 49–62.

Subsystems (n.d.). *Description of OBIS code for IEC 62056 standard protocol*. Promotic. Retrieved from https://www.promotic.eu/en/pmdoc/Subsystems/Comm/PmDrivers/IEC62056_OBIS.htm

Wi-Fi MCU for IoT applications. (2025). ESP8266 Technical Reference Version 1.7. Espressif. Retrieved from https://www.espressif.com/sites/default/files/documentation/esp8266-technical_reference_en.pdf

Author(s) Information

Goce Stefanov
Faculty of Electrical Engineering
Goce Delcev University Stip
Krste Misirkov, 10A, 2000 Stip
North Macedonia
Contact e-mail: bilijana.citkuseva@*ugd.edu.mk*

Biljana Citkuseva Dimitrovska
Faculty of Electrical Engineering
Goce Delcev University Stip
Krste Misirkov, 10A, 2000 Stip
North Macedonia

Vlatko Cingoski
Faculty of Electrical Engineering
Goce Delcev University Stip
Krste Misirkov, 10A, 2000 Stip
North Macedonia

Todor Cekerovski
Faculty of Electrical Engineering
Goce Delcev University Stip
Krste Misirkov, 10A, 2000 Stip
North Macedonia

To cite this article:

Stefanov, G., Cingoski, V., Citkuseva-Dimitrovska,. B., & Cekerovski, T. (2025). Remotely read and transfer energy meter parameters in an RF and IoT network. *The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 36,* 229-240.