Intesis®
BY HMS NETWORKS

Application note
Energy Consumption Calculation with the New Intesis 700 Series Air

Introduction
Energy Consumption from the VRF System
Power Estimation Algorithm (PEA)
Scope and Recommendations
System Design
Variables and Results
Applications
Summary

HMS

Contents

Introduction

In today's rapidly evolving world, the efficient management of energy consumption has become a critical concern for building owners. Among various energy-intensive components, the Heating, Ventilation, and Air Conditioning (HVAC) system stands out as one of the primary consumers in most buildings. Understanding and monitoring the energy usage of HVAC systems is essential to identify potential energy-saving opportunities and optimize overall energy efficiency.

In this document, we will guide system integrators through the process of understanding how HVAC installations distribute and consume energy. We will explore the integration of energy meters and the use of the new Intesis 700 Series Air gateways to obtain accurate approximations of energy consumption from individual indoor units within the Variable Refrigerant Flow (VRF) system.

By understanding energy usage, it is possible to identify areas of inefficiency, track performance trends, and make informed decisions to optimize energy consumption and reduce operational costs. Such detailed knowledge enables targeted maintenance and troubleshooting efforts, ensuring the HVAC system operates at its peak performance while minimizing unnecessary energy wastage.

The Intesis 700 Series Air gateways represent an advanced solution that integrates seamlessly with VRF installations, enhancing their energy monitoring capabilities. By integrating compatible energy meters, the BMS gains access to the approximate energy consumption data for each indoor unit in real-time.

Through the following sections, we will explore how to integrate energy meters data into the 700 Series Air gateways using the Intesis MAPS configuration tool. We will outline the necessary wiring connections, provide guidelines for a proper setup and calibration, and explore the available options for accessing and analyzing energy consumption data.

Energy Consumption from the VRF System

Regardless of the brand, in a VRF system, the energy consumption is distributed depending on the number of indoor units connected, with the outdoor unit being the most demanding element.

When there's only a single indoor unit, the whole power consumption from the entire system can be assigned to that unit.

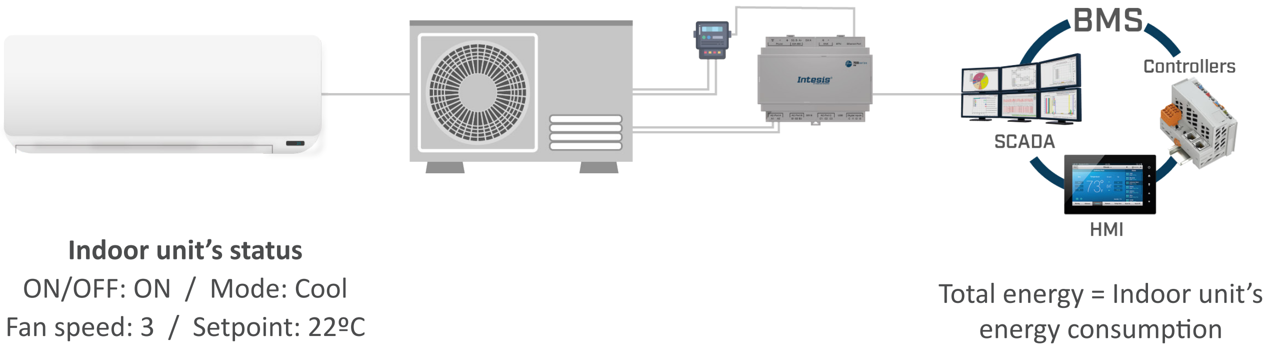


Figure 1.- Energy consumption of a VRF system with a single indoor unit.

But when having multiple indoor units, calculating the energy consumed by each one becomes more complex.

The configuration of each indoor unit, especially the input power, the operation time, the operation mode, the fan speed, and the setpoint temperature, has a remarkable impact on the system's energy consumption. Environmental factors like the thermal insulation of the room and the ambient temperature might also affect the overall performance.

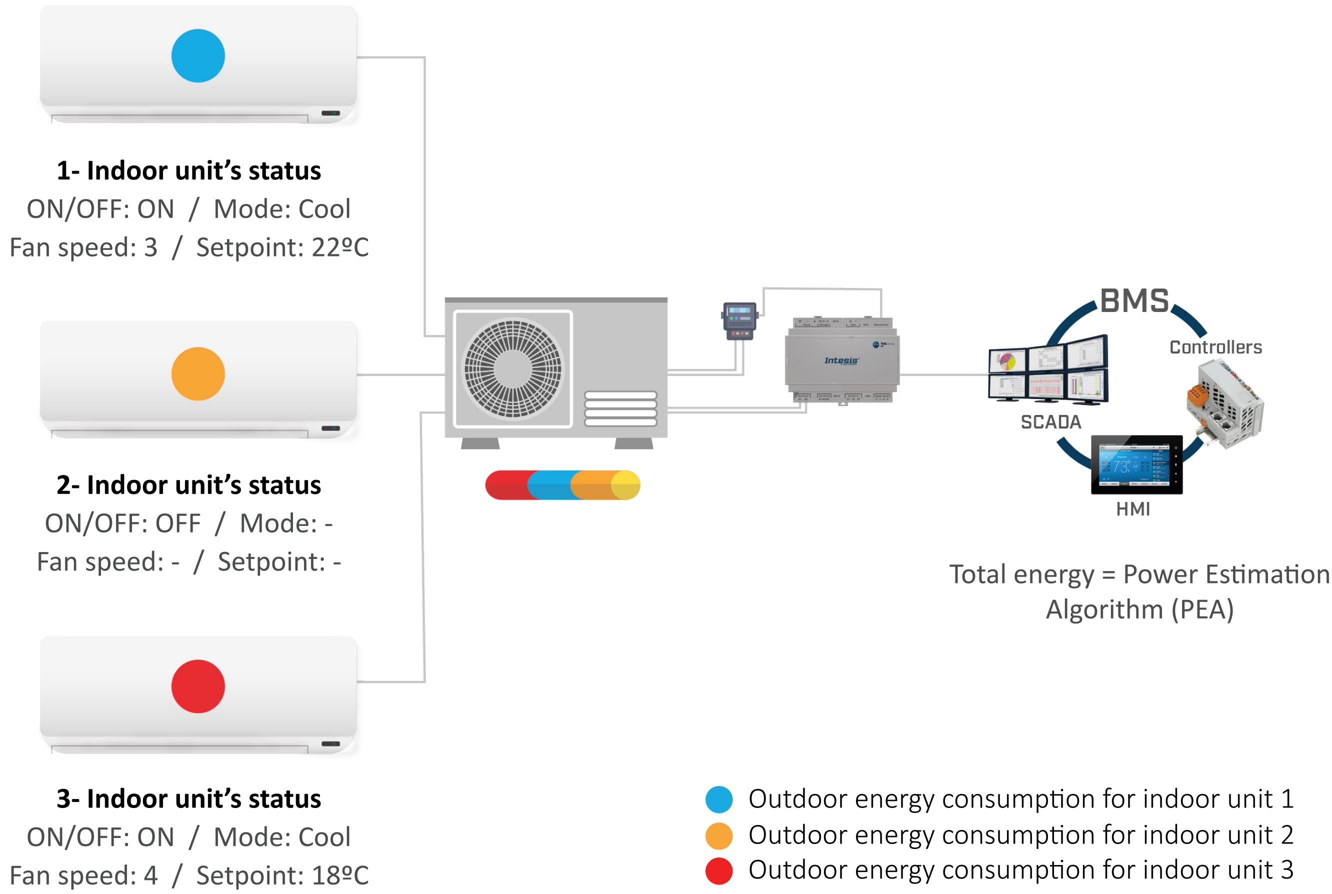


Figure 2.- Energy consumption of a VRF system with multiple indoor units.

When having a multi-unit VRF system, we need a complex mathematical algorithm to calculate the energy consumed by each indoor unit. This algorithm must consider all the aforementioned variables to provide a highly accurate estimation.

Power Estimation Algorithm (PEA)

In Intesis we have developed a Power Estimation Algorithm (PEA) in collaboration with the leading AC brands to calculate the energy consumption of each indoor unit in a VRF installation. This algorithm is integrated into the Intesis 700 Series Air gateways, providing users with valuable insights into energy usage.

The Power Estimation Algorithm considers various factors to determine how the outdoor unit distributes the energy among the corresponding indoor units it serves. These factors include the return air temperature, the position of the electronic expansion valve, and other reference values determined by the AC manufacturer. By leveraging mathematical calculations and these input parameters, the algorithm provides a reliable estimation of the energy consumption for each indoor unit.

Thanks to the expertise and input from the VRF manufacturers, Intesis ensures that the algorithm is aligned with industry standards and best practices. This collaboration not only ensures the accuracy of the estimation but the reliability of the result as well. Building automation professionals can trust the Intesis 700 Series Air gateways and their advanced Power Estimation Algorithm to understand how energy is consumed within their VRF systems, facilitating better energy management and optimization strategies.

Scope and Recommendations

Despite enabling the BMS to access all relevant energy data from the VRF installation, our system has a defined scope and use limitations:

RELIABLE ESTIMATION

The Power Estimation Algorithm (PEA) does not provide exact data from the total energy consumption of each indoor unit, but a reliable estimation for understanding the overall system performance and wastage areas.

NOTICE
NOTICE Intesis does not recommend using this algorithm for billing purposes.

SUPPORTED METER TYPES

To ensure proper functioning, the energy measurement can only be performed through two types of meters: Modbus TCP meters and pulse meters.

NOTE
NOTE Modbus RTU meters are also allowed if you use a Modbus router to convert the data into Modbus TCP.

Modbus TCP meters communicate over a Modbus TCP/IP network, providing energy consumption measurements in a digital format. The energy data is stored in Modbus registers that the Intesis gateways can read through its Ethernet port.
Pulse meters or pulse counters have a pulse output terminal that generates electrical pulses in proportion to the energy consumed by the VRF load. The frequency of the pulses corresponds to a predefined energy increment that the Intesis gateways can read through its binary inputs.

METERING LIMITATIONS

The type of meter connected to the Intesis gateway should be consistent throughout the installation. Mixing different meter types, such as having both pulse meters and Modbus TCP meters within the same installation is not allowed, as it can lead to inaccurate readings and communication errors.
The maximum number of meters that can be connected to the Intesis gateway is three, either on the Ethernet port or on the binary inputs.

⚠ CAUTION
CAUTION Whenever it is possible, connect only one meter per outdoor unit. Having several outdoor units connected to the same meter might affect the accuracy of the results.

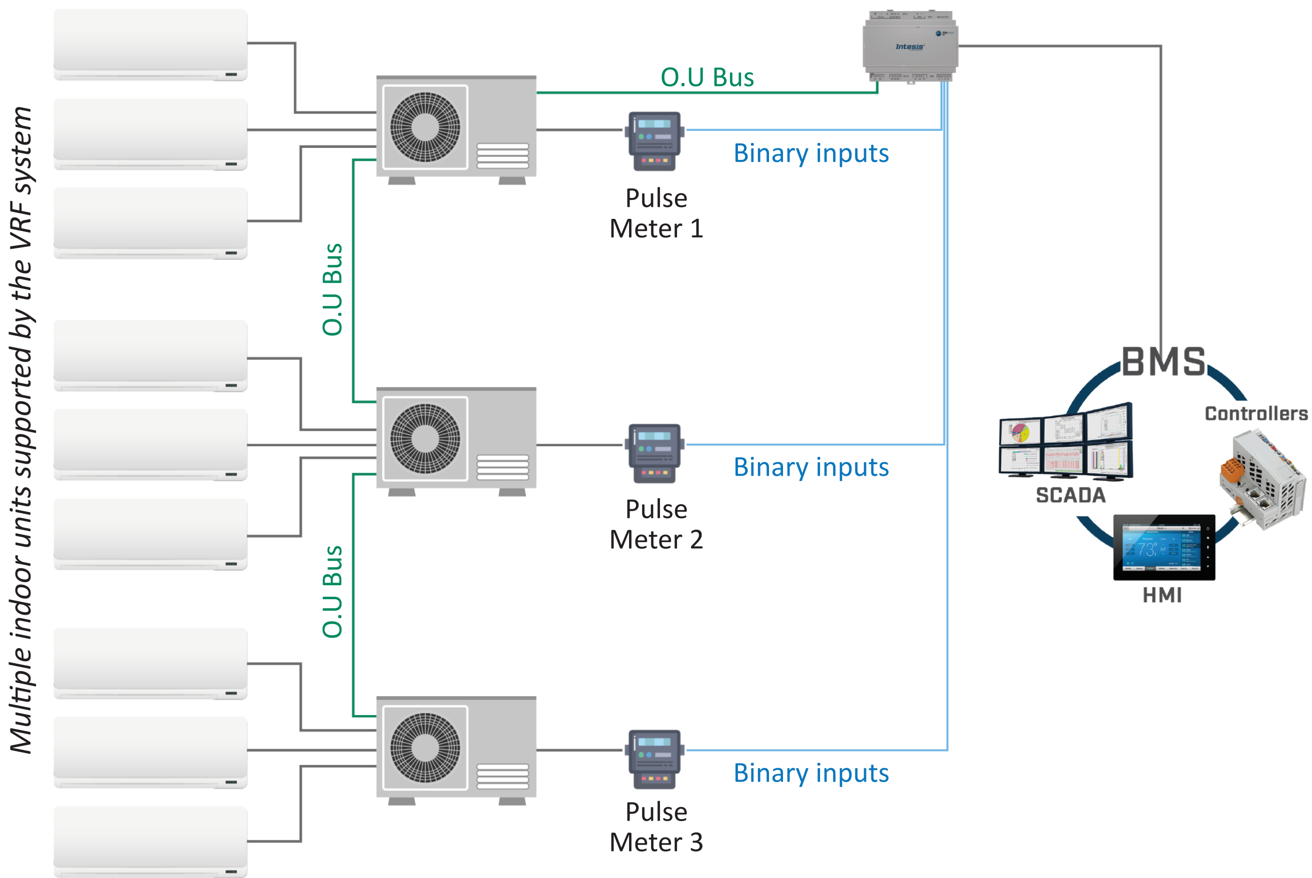


Figure 3.- Maximum capacity when using pulse meters.

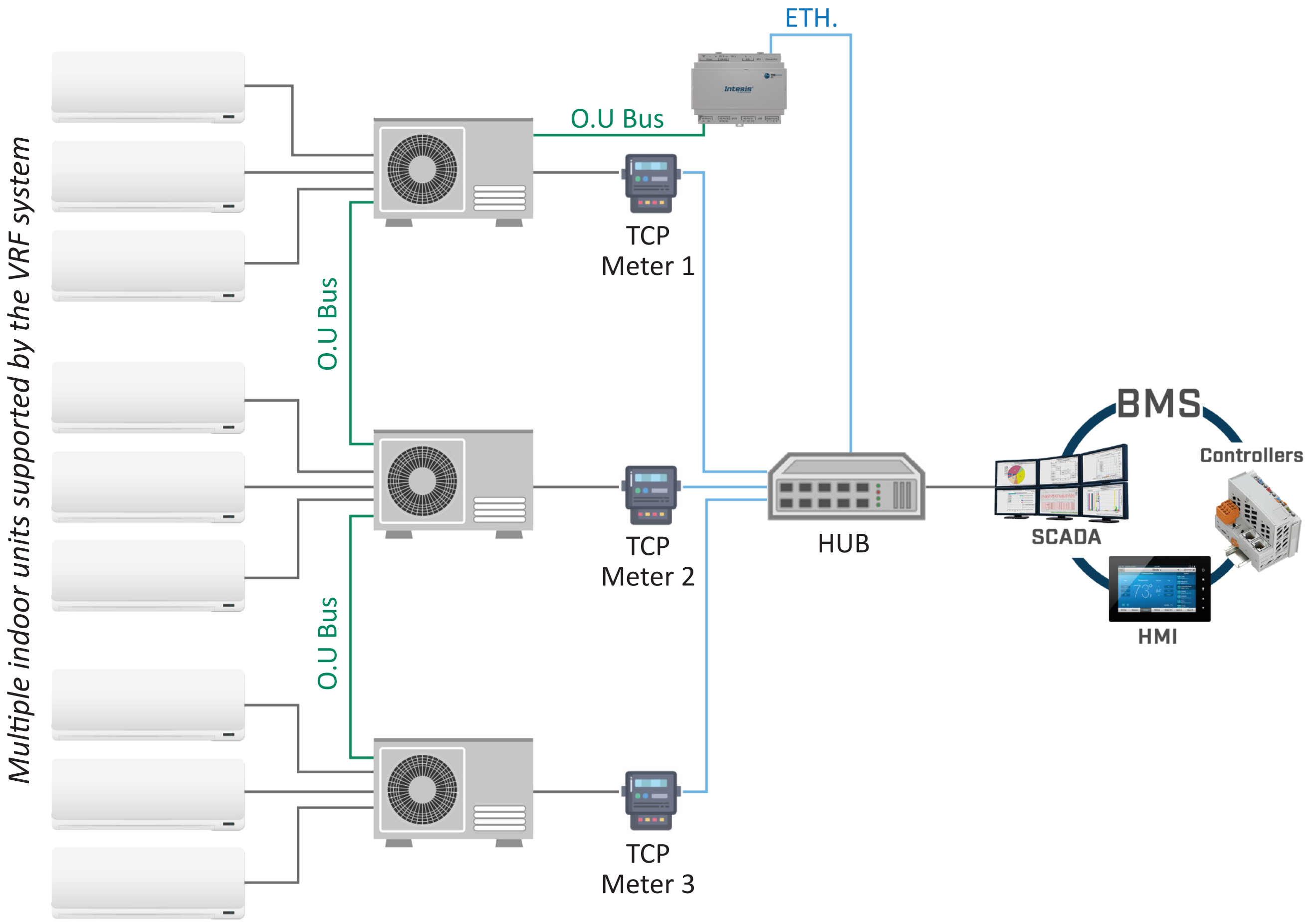


Figure 4.- Maximum capacity when using TCP meters.

DATA ANALYSIS

The data analysis is covered by the BMS or controller, therefore, it must be connected, configured, and mapped with the signals provided by the Intesis 700 Series Air gateway. A BMS can manage statistics and historical events. It can also monitor and analyze the energy usage of each indoor unit in real time, allowing facility managers to identify inefficient units or detect anomalies. This enables optimizing energy consumption, implementing energy-saving strategies, and making informed decisions regarding system operation.

NOTICE
NOTICE The Intesis 700 Series Air gateways don't provide any user interface for data analysis by itself.

System Design

To accomplish the integration of the energy consumption variables within the BMS, the following elements must be in place:

- VRF Installation
- Intesis 700 Series Air gateway
- Intesis MAPS configuration tool
- Energy meters
- BMS/Controller

WIRING DIAGRAM FOR THE INTESIS 700 SERIES AIR GATEWAYS

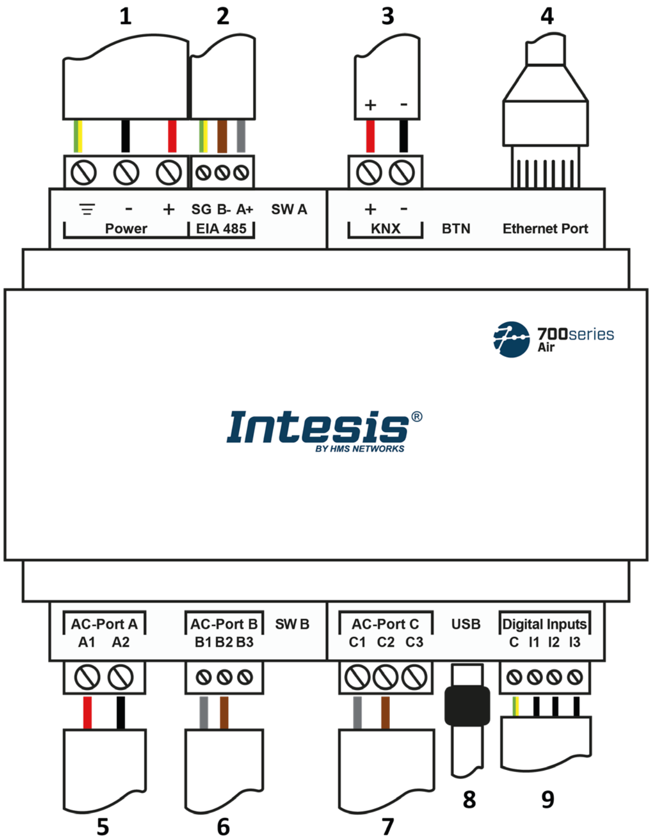


Figure 5.- Wiring diagram (Intesis 700 Series Air).

1. **Power supply** (check all technical specifications in your gateway's user manual).

2. Communication port for **EIA-485**.

3. Communication port for **KNX**.

4. **Ethernet port** for configuration purposes and to connect IP protocols or TCP energy meters.

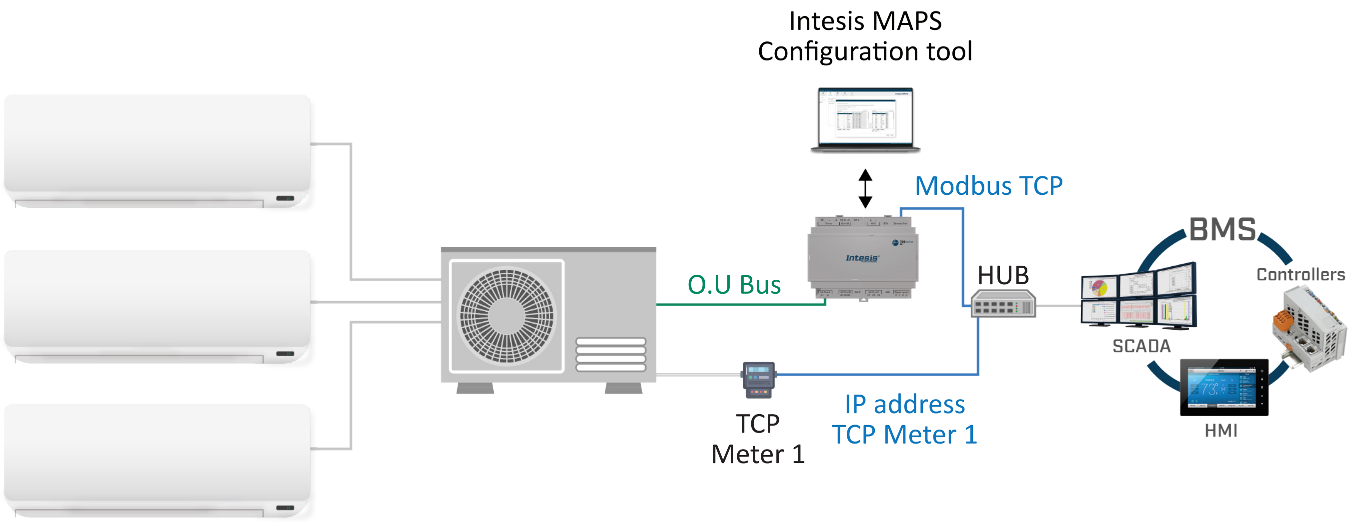
5. Connector for **VRF brand type 1** (confirm which AC port you should use in the gateway's user manual).

6. Connector for **VRF brand type 2** (confirm which AC port you should use in the gateway's user manual).

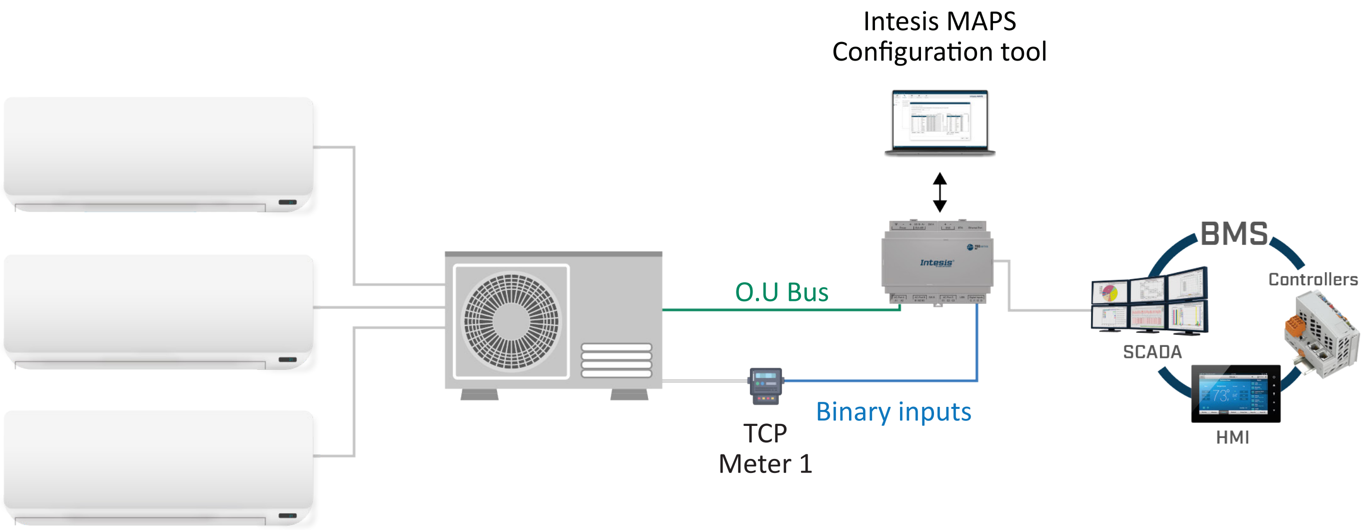
7. Connector for **VRF brand type 3** (confirm which AC port you should use in the gateway's user manual).

8. **USB port** for configuration and troubleshooting purposes.

9. **Digital inputs** for the connection of pulse eters.



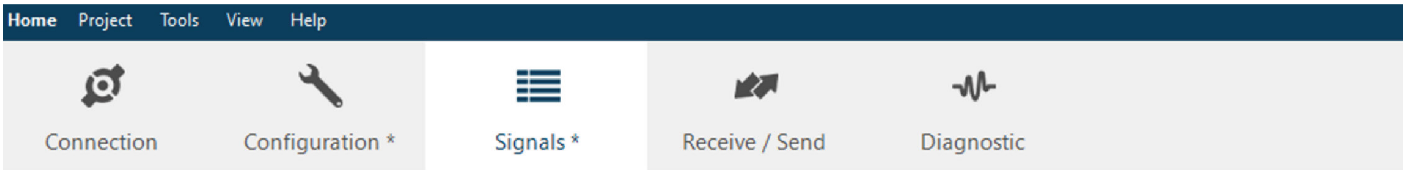
TIP
TIP The total number of indoor units that can be connected to each outdoor unit depends on the VRF brand and topology. It is not a limitation of the Intesis gateways.



Variables and Results

After setting up all the elements of the installation, configure the Intesis 700 Series Air gateway parameters using the Intesis MAPS configuration tool. To enable the energy consumption function, please follow the steps explained in the Intesis MAPS user manual.

The energy consumption result is provided through three objects or variables associated with each indoor unit.



			Modbus Slave					VRF		
#	Active	Description	Data Length	Format	Address	Bit	Read / Write	Unit ID	IU	OU
58	☑	Consumption Yesterday (Wh)	32	0: Unsigned	128	-	0: Read	Unit 1 - Indoor Unit 1	0	1
59	☑	Consumption Today (Wh)	32	0: Unsigned	130	-	0: Read	Unit 1 - Indoor Unit 1	0	1
60	☑	Consumption Total (Wh)	32	0: Unsigned	132	-	0: Read	Unit 1 - Indoor Unit 1	0	1

Figure 6.- Energy consumption signals from each indoor unit in MAPS.

■ CONSUMPTION YESTERDAY

It stores yesterday's electrical consumption of the indoor unit. It represents the consumed energy within a specific period, from 48 to 24 hours ago relative to the current moment.

■ CONSUMPTION TODAY

It refers to the energy consumption of the indoor unit during the last 24 hours.

■ CONSUMPTION TOTAL

This is the total energy spent by the indoor unit from the initialization of the Intesis 700 Series Air gateway.

The variables are expressed in a numeric format expressed in watt-hour (Wh) or Kilowatt-hour (kWh). This can be defined in Intesis MAPS during the meter's data configuration.

If required, these three variables can be divided between Cool Mode or Heat Mode, to provide the BMS with more specific data about the energy that each indoor unit has spent while working on each operation mode.

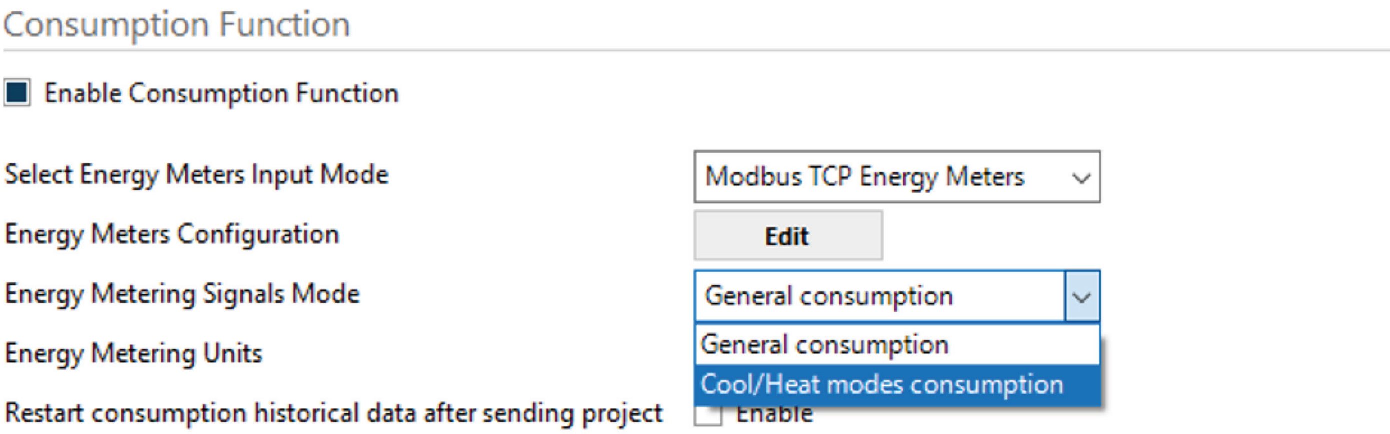
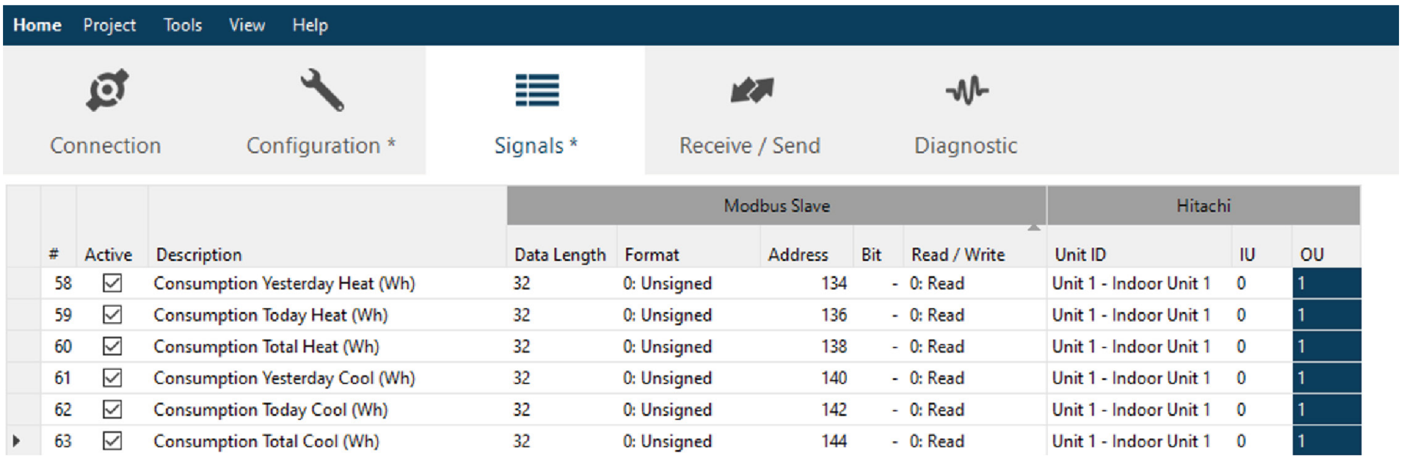


Figure 7.- Enabling Cool/Heat mode consumption on the meter's configuration.



#	Active	Description	Modbus Slave					Hitachi		
			Data Length	Format	Address	Bit	Read / Write	Unit ID	IU	OU
58	☑	Consumption Yesterday Heat (Wh)	32	0: Unsigned	134	-	0: Read	Unit 1 - Indoor Unit 1	0	1
59	☑	Consumption Today Heat (Wh)	32	0: Unsigned	136	-	0: Read	Unit 1 - Indoor Unit 1	0	1
60	☑	Consumption Total Heat (Wh)	32	0: Unsigned	138	-	0: Read	Unit 1 - Indoor Unit 1	0	1
61	☑	Consumption Yesterday Cool (Wh)	32	0: Unsigned	140	-	0: Read	Unit 1 - Indoor Unit 1	0	1
62	☑	Consumption Today Cool (Wh)	32	0: Unsigned	142	-	0: Read	Unit 1 - Indoor Unit 1	0	1
63	☑	Consumption Total Cool (Wh)	32	0: Unsigned	144	-	0: Read	Unit 1 - Indoor Unit 1	0	1

Figure 8.- Consumption signals for Cool/Heat modes.

Applications

The HVAC system's energy consumption data, collected by the Intesis 700 Series Air gateways and presented by the consumption variables, offers essential applications for building owners and facility managers:

- **ENERGY EFFICIENCY ANALYSIS:**

By monitoring the energy consumption of the indoor units over different time periods, it is possible to analyze the energy efficiency of the HVAC system. You can identify patterns, trends, and anomalies in energy usage to optimize the system performance and identify opportunities for energy saving.

- **COST ALLOCATION:**

The energy consumption data enables to allocate energy costs among different tenants, departments, or areas within a building. By tracking the indoor units' consumption, an estimation of the electricity cost can be shared, based on actual energy usage, promoting fair and transparent cost distribution.

- **SYSTEM MAINTENANCE AND TROUBLESHOOTING:**

The energy consumption information provides insights into the performance of indoor units. As shown throughout this document, this enables monitoring variations in energy consumption to detect any abnormalities or malfunctions. An unusually high or fluctuating energy usage may indicate issues with specific units, prompting timely maintenance and troubleshooting to ensure an optimal system operation.

- **SUSTAINABILITY:**

The ability to track and analyze the energy consumption from the indoor units supports sustainability efforts within buildings. It allows identifying areas with high energy usage and implementing targeted measures to reduce energy consumption, promoting environmental sustainability, and achieving energy efficiency goals.

The energy a building demands and its energy consumption patterns vary a lot depending on the building's function and the activity of its occupants. Here are a few examples:

- **COMMERCIAL BUILDINGS:**

In commercial buildings such as offices, retail spaces, or hotels, monitoring daily energy consumption helps assess the efficiency of HVAC systems in relation to the building's occupancy levels. By analyzing energy usage during working hours, it's possible to identify opportunities for optimizing energy consumption during non-peak times or periods of low occupancy. This understanding is very valuable for cost savings and aligning energy usage with the building's operational needs.

- **RESIDENTIAL BUILDINGS:**

In residential buildings, understanding the daily energy consumption allows tracking and managing energy usage patterns, identifying high-consumption periods, and making informed decisions about adjusting temperature settings. This knowledge helps to optimize comfort while minimizing energy waste and costs.

- **EDUCATIONAL INSTITUTIONS:**

Schools and universities have specific operating hours and occupancy patterns. Monitoring energy consumption enables the evaluation of energy usage during school hours, after-school activities, and weekends across the different building areas. By identifying periods with excessive energy consumption, they can implement energy-saving measures or align HVAC schedules with occupancy patterns, resulting in energy efficiency and cost reduction.

- **HEALTHCARE FACILITIES:**

Hospitals and healthcare facilities have unique energy requirements due to their round-the-clock operations and specialized equipment. Understanding energy consumption is crucial in critical temperature areas such as operating rooms, intensive care units, or diagnostic labs. By tracking energy consumption patterns, it's possible to identify potential energy-saving opportunities without compromising patient care, comfort, or safety equipment operation.

- **INDUSTRIAL BUILDINGS:**

Industrial buildings, including manufacturing plants and warehouses, often have high-energy demands associated with equipment operation, ventilation, and lighting. Monitoring energy consumption helps to identify energy-intensive processes or equipment that may contribute to overall energy usage. This understanding allows optimizing operational schedules, implementing energy management strategies, and exploring energy-efficient technologies for improved productivity and cost control.

Summary

This application note focuses on the calculation and understanding of energy consumption in HVAC systems, particularly Variable Refrigerant Flow (VRF) installations, using the Intesis 700 Series Air gateways. By integrating energy meters, users can obtain accurate estimations of energy consumption from individual indoor units within the VRF system. This is where the Power Estimation Algorithm (PEA) developed by Intesis and the HVAC makers plays an important role, considering various factors to know how outdoor units distribute the energy among the indoor units it serves. The PEA provides reliable estimations of energy consumption, facilitating energy management, optimization strategies, and identifying inefficient units.

With this document, the reader will comprehend the benefits of energy consumption estimation, including efficiency analysis, cost allocation, system maintenance and troubleshooting, and sustainability efforts. It also provides recommendations and guidelines for integrating energy meters and analyzing energy consumption data within a building management system.

700series Air