Technical Explanation for Power Monitoring Devices

CSM_PowerMonitors_TG_E_1_1

Introduction

What Is a Power Monitoring Device?

A Power Monitoring Device measures power consumption in order to support energy-saving activities.
Electricity is not visible, but it is a familiar, convenient form of energy that is converted into heat, light, sound, power, or other forms and can be used. It is indispensable for our daily lives.
The purpose of environmental protection has been added to the original purpose of energy saving activities to reduce the cost of electricity rates. Moreover, currently it is necessary to produce products while conducting energy saving and environmental protection activities and also enhancing productivity and quality.
Attaining these purposes requires measurement devices that can be used to easily check power consumption and constantly measure it to help save energy.

Types of Power Monitoring Devices

Portable Devices
These Power Monitoring Devices perform checks according to the rated current and circuit type.

Portable Power Monitor
ZN-CTX21
Checks electric power essentially anywhere with simple, advanced functions.

- Dedicated CT Units: six models each for standard and branch types.
- Measurement is possible for single-phase two-wire, single-phase three-wire, three-phase three-wire, and three-phase four-wire systems.
- Data can be stored in SD cards.

Permanently Installed Devices
These Power Monitoring Devices are mounted in facilities and equipment to take measurements.

• On-panel Devices

Smart Power Monitor
KM50-E/-C
Accurate and smart measurement for constant monitoring.

- Logs and stores each types of measurement data internally.
- Energy classification (-E).
- Input pulses from flow meters and other devices.

• In-panel Devices

Smart Measurement and Monitor Unit
KE1
Unit structure that enables power, earth leakage and momentary voltage sags monitoring with just one Unit.

- Connect CT and ZCT Expansion Units for multi-circuit measurements.
- Alarms for momentary voltage sags as short as 25 ms and voltage fluctuation logging
- Expansion with DeviceNet Communications Unit

Multi-circuit Smart Power Monitor
KM1
Drastically reduces the cost and work involved in visualization.

- Input of two systems with different voltages.
- Link up to 5 Units for multi-circuit measurement up to 36 circuits.

For details on these products, refer to the KM50 Series Catalog (N167-E1-01) and the KM1 Series Catalog (N170-E1-01).

Power Measurement Mechanism

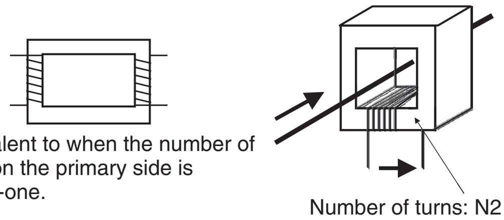
Measuring Current

One of the methods for measuring the current flowing through wires is to use current transformers (CTs) that apply the principle of transformers.

In a current transformer, instead of the transformer primary coil, the wire for which the current is being measured passes through the core. The number of turns in the primary coil operates as a transformer. A current that is inversely proportional to the number of turns in the secondary coil flows through the secondary coil.

Current value flowing through primary coil:	1
Number of turns in secondary coil:	N2
Current value flowing through secondary coil:	I2

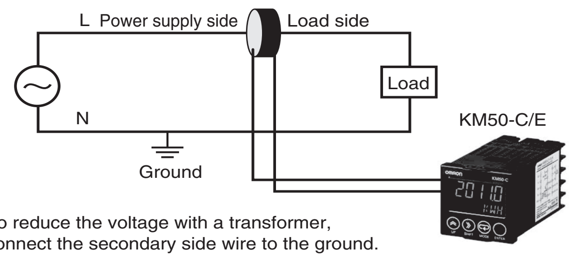
I2 = I1 / N2



Differences in Measurement Methods Using Distribution Lines

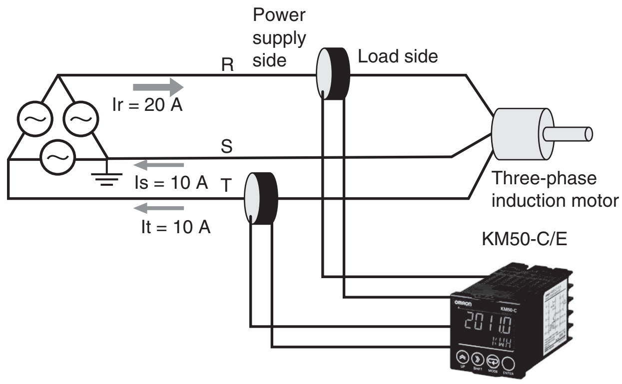
There are various types of AC distribution line. The number of current transformers and their measurement positions depend on the type.

Single-phase Two-wire System

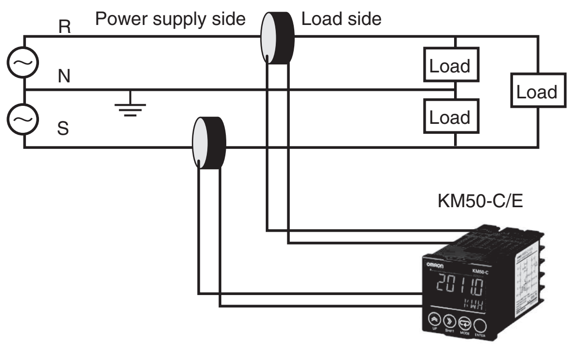


To reduce the voltage with a transformer, connect the secondary side wire to the ground. The side connected to ground is called the N phase and the other side is called the L phase.

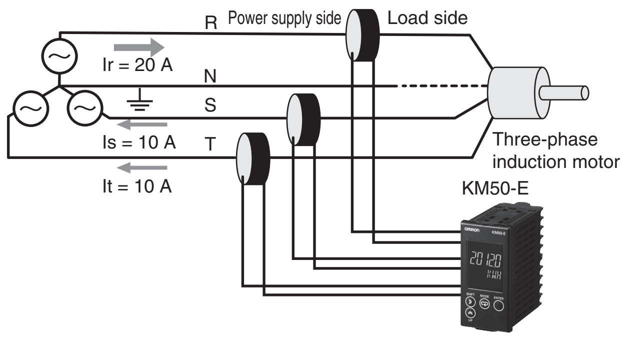
Three-phase Three-wire System



Single-phase Three-wire System



Three-phase Four-wire System

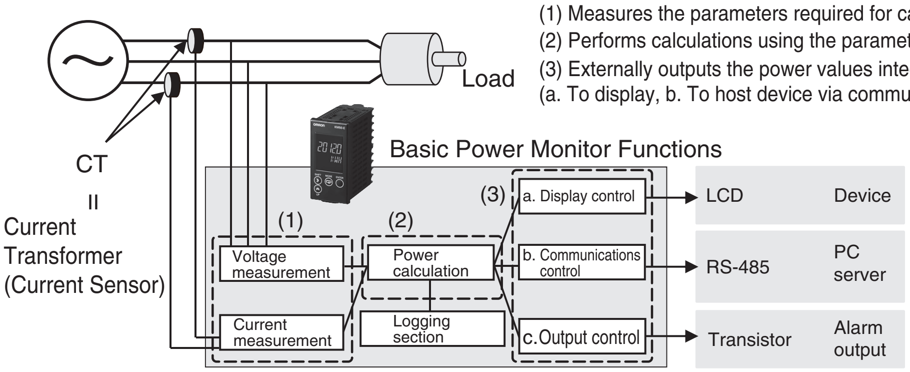


Description of Operations

Basic Operation of a KM50 Smart Power Monitor

The KM50 measures the AC current and voltage, converts these to the power consumption, and outputs the result.

(1) Measures the parameters required for calculating the electric power.
(2) Performs calculations using the parameters from (1) and converts them into power values.
(3) Externally outputs the power values integrated over time (power consumption)
(a. To display, b. To host device via communications, and c. To alarm output)



Explanation of Terms

Electric Power and Power Consumption

Electric power expresses the amount of work that electricity can do and it is the amount of work done by electricity in one second.

Power (watts) = Voltage (volts) x Current (amperes)

W = V x I

The unit is the watt (W).

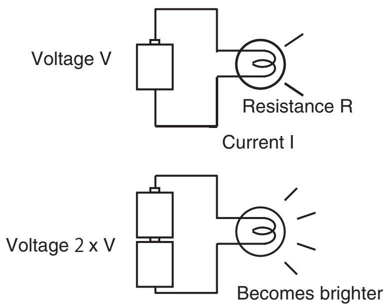
Power consumption is the amount of energy used, i.e., how much work the electricity did.

It is calculated as follows: Power (W) x Time (h).

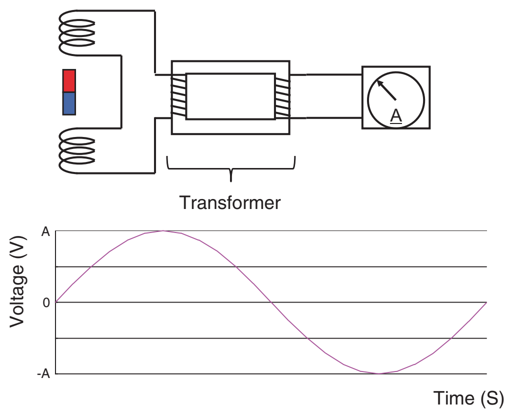
The unit is the watt-hour (Wh).

Examples: 1 kWh = 100 V × 10 A × 1 hour

10 kWh = 100 V × 100 A × 1 hour



< Mechanism of Electricity Generation >



Why AC?

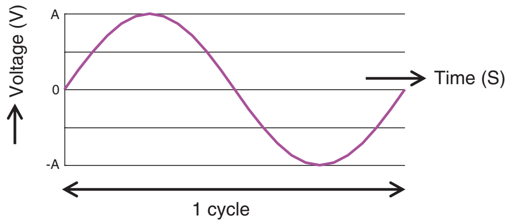
(1) It is simple to produce an electrical generator for AC power.
As shown in the above figure, if you rotate a magnet, electricity is generated (Fleming's rule).
In the past, water wheels were used. Nowadays, turbines are used.

(2) It is simple to convert an AC voltage.
Long-distance transmission is easy for AC electric power. You can change to the desired voltage by changing the number of turns in the transformer.
Transmitting electricity at higher voltage creates lower loss.

(3) Low-maintenance AC motors can be used.

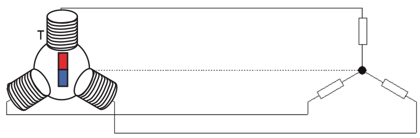
AC

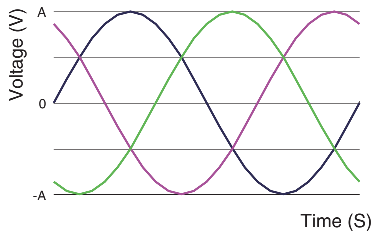
AC (alternating current) means that the voltage is changed alternately with time. Frequency expresses how many cycles of the wave are repeated in one second. The unit is the hertz (Hz).

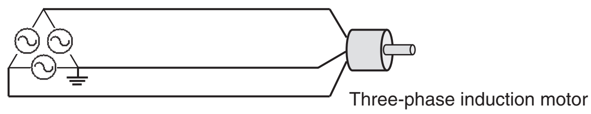


Three-phase AC

Three-phase AC is AC that combines 3 systems of single-phase AC with phases that are 120° different from each other.

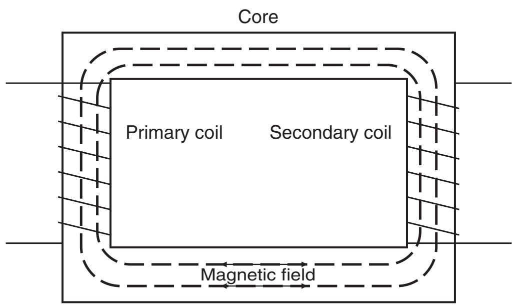






Transformer

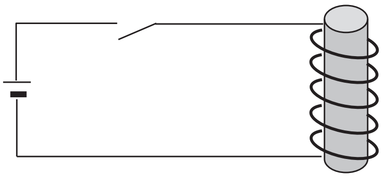
A transformer increases or decreases the voltage.



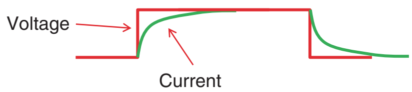
· When current flows in the primary coil, a magnetic field is generated in the coil and a voltage is generated in the secondary coil.
· The magnitude of this voltage is proportional to the number of turns in the coil. The more turns, the higher the voltage.

Inductive Loads

An inductive load is a load in which the wires are wound into a coil. Motors are a typical inductive load.



Characteristics of Inductive Loads
1. An inductive load resists the flow of electricity.
2. The flow of electricity cannot be readily stopped by turning it off.



Apparent Power

Volt-ampere (VA)

VA is calculated by multiplying the voltage (V) and current (A). Apparent power is the value found by simply multiplying the voltage and the current.

Active Power

Watt (W)

Active power is power that does actual work and is consumed as energy.
The AC electricity normally used in homes has apparent power (VA) and active power (W). The active power is the apparent power multiplied by the power factor.

Reactive Power

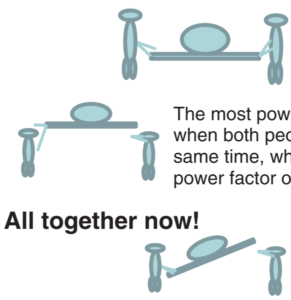
Volt-ampere Reactive (Var)

This is the power that goes back and forth between the power supply and the load without doing any work.

Power Factor

There is active power and reactive power. The power factor is the proportion of active power. This is like the efficiency of electricity usage.

Lifting a Heavy Load with Two People



Electric Power
Apparent power (VA) = Voltage (V) x Current (A)
Active power (W) =
Voltage (V) x Current (A) x Power factor

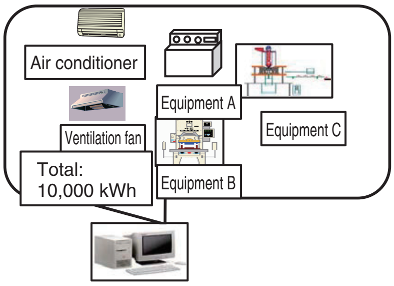
Further Information

How to Promote Energy-Saving Activities

Why Is Visualization Important?

Centralized Measurement of Power Consumption

Before Visualization...

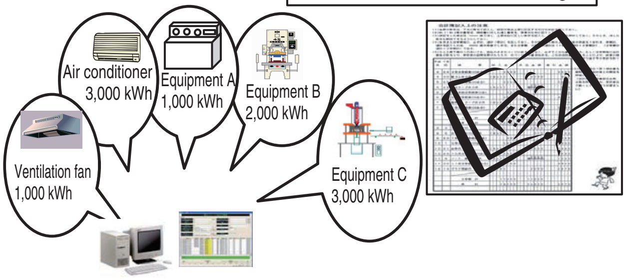


If you only measure the total power consumption, you do not know how much energy is being used where, so it is difficult to take appropriate measures to save energy.

Individual Measurements of Power Consumption

With Visualization...

This is the same concept as using household account books to 'visualize' where to make savings!



Individual measurements enable you to figure out when, where, and how much energy you are using for each application and it makes apparent the points where you can save energy.

The Basics of Improved Energy Saving through Visualization

Key Points for Data Collection

Visualization Selection

Implementing Visualization Levels 1, 2, and 3

- ◆Measurement purposes
- ◆Types of data
- ◆Number of measurement points
- ◆Measurement periods

Concept of Extracting Improvement Points

Analyzing from the Perspective of Seven Types of Waste

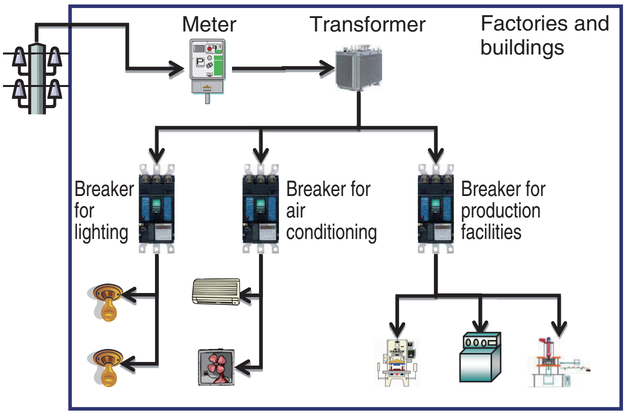
- ◆Comparison of the actual data against standards

Diagnostics

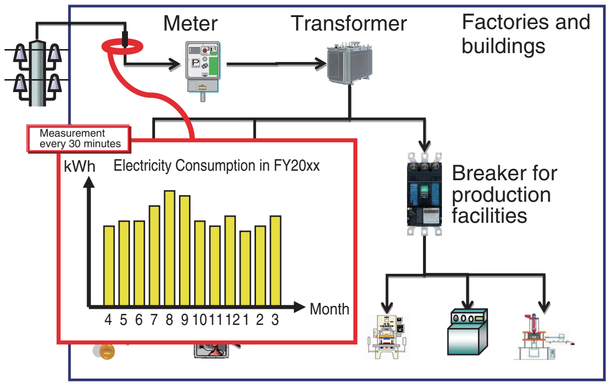
- ◆Awareness of the amount of equipment required
- ◆Reviewing standards from the perspectives of enhancing quality and productivity, and energy saving
- ◆Imitating successful examples

Visualization Levels 1, 2, and 3

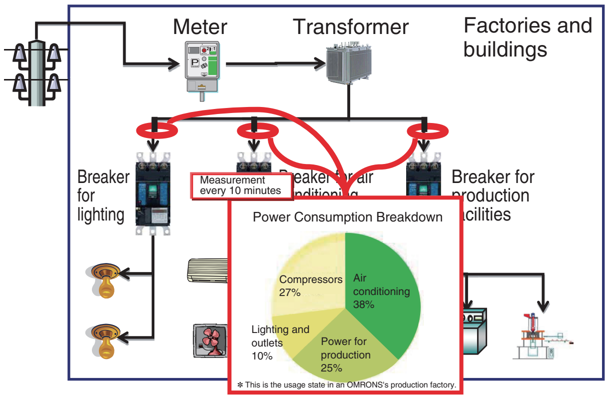
Visualization can be divided into three visualization levels according to the power consumption that is visualized and the type of power consumption data that is collected. With the facility shown below, you see what type of power consumption is measured and visualized.



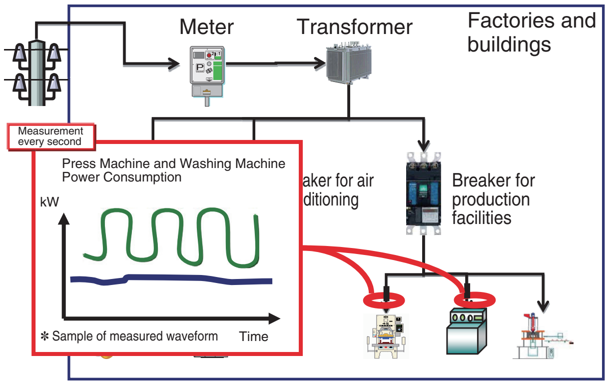
(1) Visualization Level 1: Demand Measurement (Total Consumption)



(2) Visualization Level 2: Secondary Side Measurement (Consumption Breakdown)



(3) Visualization Level 3: Individual Measurement (Energy Balance)



Sensors
Switches
Safety Components
Relays
Control Components
Automation Systems
Motion / Drives
Energy Conservation Support / Environment Measure Equipment
Power Supplies / In Addition
Others
Common

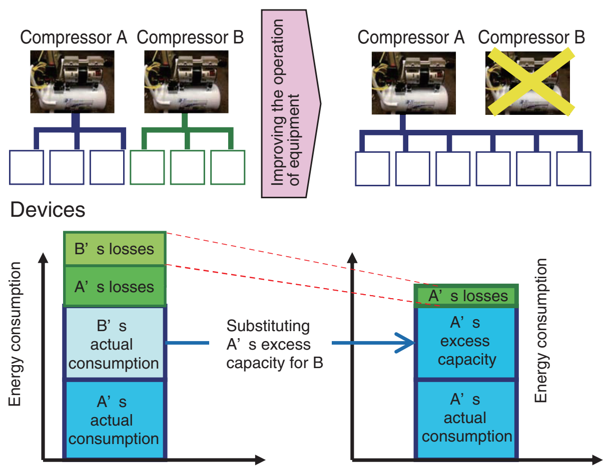
The Seven Types of Waste

Extract margin for improvement from the perspective of seven types of waste.

	Level 1	Level 2	Level 3
(1) Waiting	Wasted energy consumption while waiting and not operating		
(2) Margins	Waste of energy exceeding the demand and required standards		
(3) Combinations	Waste from equipment combinations and inadequate set values (in parallel or in series)		
(4) Application	Waste from application that is wrong for the purpose		
(5) Wasted energy	Waste from throwing out energy rather than using for a different purpose		
(6) Equipment problems	Waste from poor energy efficiency due to insufficient maintenance, etc.		
(7) Old equipment	Waste from poor energy efficiency due to old equipment		

Example 1 Visualization Improvement Example of Level 2: Margins and Combinations

There is a tendency for factory equipment to be laid out and designed with extra capacity. The key point for eliminating waste is to discover where it is possible for the perspectives of margins and combinations to complement each other and to help stop waste.



Example 2 Visualization Improvement Example of Level 3: Waiting

Look at certain production equipment, link energy usage and production timing and stop or reduce consumption during times that are not creating added value (i.e., unrelated to production).